

Phys. Sp.

483¹ - 113

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REPORT ON MISSOURI RAINFALL, WITH AVER-
AGES FOR 10 YEARS ENDING DEC., 1887.

ON THE OUTPUT OF THE NON-CONDENSING STEAM
ENGINE AS A FUNCTION OF SPEED AND PRESSURE.

— BY —

FRANCIS E. NIPHER.

*From the Transactions of the St. Louis Academy of Science,
Vol. V., No. 3.*

Report on Missouri Rainfall, with Averages for Ten Years ending December, 1887.

By FRANCIS E. NIPHER.

In the autumn of 1877 the writer secured the coöperation of observers in various parts of Missouri, with a view of making observations on rainfall and temperature. The volunteer organization then formed, and which began operations in December of that year, was known as the "Missouri Weather Service." The observers were nearly all furnished with rain-gauges similar to those already in use in the Iowa Weather Service, and for which they paid the cost price. These gauges were plain cylinders of heavy tin plate, having a depth of one foot and a diameter of 7.06 centimeters, so that each cubic centimeter of water caught represented a hundredth of an inch of rainfall. The rainfall was, however, in most, if not all, cases determined by observing the wetted part of a small box-wood scale, graduated to inches and tenths.

The rain-gauge was the only instrument furnished to observers by the central office. In a few cases, observers bought Green's thermometers, and others observed temperatures with ordinary thermometers. The labor involved in the direction of a complete meteorological service was, however, greater than the director could undertake, and it has unfortunately happened that the supervision needed in order to obtain first-class rainfall data could not be given. It was hoped that Missouri would follow the example of Iowa, and establish the weather service as a state institution, and to that end a bill was introduced into the Legislature in 1882 to establish such a weather service, granting a couple of thousand dollars per annum for its support. The consideration of this bill furnished an occasion for mirth to some of the members of that body, but failed to awaken any general interest.

This experience was, in fact, so depressing that no further attempt has been made in that direction.* Twenty-five other states

* Since the above was written a bill has been introduced into the Legislature by Mr. Tuttle, of Pettis county. There is little reason to believe that it will pass, although mem-

now have weather services, and the number receiving state support is increasing in a very gratifying way. The function of the state weather service is as clearly distinct from that of the national weather service as that of the state government is from the national. The state weather service should study the climate of the state, giving particular attention to the distribution of rainfall and temperature. It should also make a complete study of local summer storms—which are of such supreme importance to the farmer. When the telephone shall have become public property, so that county telephone services can be organized to serve farmers at lower rates, it will be possible to combine such service with local storm warnings which will save millions of dollars to the farmers of the state. In the mean time the local peculiarities of these storms should receive a thorough investigation in each state where the people understand their own interests sufficiently to establish a weather service, and a state weather service is the only feasible way to study them. The national weather service should give warning of cold waves and the larger storms, occurring mainly in winter, the movements of which are revealed by the barometer. These predictions are of great value to shipping on the lakes and the Atlantic coast, and to dealers in perishable goods. In this direction lies the great value of the national weather service, and the state services could give efficient aid in distributing such predictions. But the national weather service will never be able to deal with summer thunder-storms, which usually cover only a few counties. It will be the work of state weather services to establish systems of “harvest warnings,” and in the near future this will be done.

The present paper gives the results of ten years of rainfall observation by the observers of the Missouri Weather Service. This work has required much patience and self-denial on the part of the observers, and they are entitled to the thanks of the people of the state.

Before proceeding to a description of the stations of observation, it should be stated that the observations made by those reporting regularly to this office have all been reduced anew from

bers of the appropriation committee were disposed to recommend it if the Director would consent to serve without salary. As a rule, statesmen who make such propositions do not take their own medicine.

the daily observations, on file at the Washington university. This work, as also the working out of all the average values, has been done by Serg't G. A. Weber, of the Signal Service, now acting as assistant in this office. In the following list of stations, those reporting to this office are indicated by the initials M. W. S. following the name of the station or observer. In case of M. W. S. observers, where the gauge is not described, it will be understood that the Iowa gauge was used. Other data has been republished from Mr. Schott's paper in the "Smithsonian Contributions to Knowledge," vol. xxiv. Such stations are indicated by an S. following the name of the station or observer. The latitudes and longitudes are only approximate. The word "*grade*" preceding the word "elevation" means that the altitude given is that of the railroad track at that point.

Allenton, St. Louis Co., Mo. S. Lat. $38^{\circ} 39'$; Lon. $90^{\circ} 45'$: elevation 482 ft. A. Fendler obs.

Ashley, Pike Co., Mo. S. Lat. $39^{\circ} 20'$; Lon. $91^{\circ} 12'$: elevation about 850 ft. Jno. C. Watkins obs.

On Big Creek, Lincoln Co., Mo. Lat. $38^{\circ} 57'$; Lon. $90^{\circ} 59'$. F. L. Jabin obs. M. W. S., Jan. 1878 to Apr. 1882. E. J. W. Pollien obs. M. W. S. after Apr. 1882 to Jul. 1883.—Mr. Jabin's gauge was about 56 rods s.w. of the n.e. corner of sec. 28, tp. 48, r. 1 w. of the 5th principal meridian. The top of the gauge was 24 in. above the ground. The nearest objects were, a clump of cedars 14 feet high, 25 ft. e.; smoke-house 16 ft. high, 75 ft. s.; hen-house 12 ft. high, 50 ft. n. The latter stood about 4 ft. below the level of the top of the rain-gauge.

Bolivar, Polk Co., Mo. Lat. $37^{\circ} 35'$; Lon. $93^{\circ} 30'$: elevation 1,000 ft. J. A. Race obs. S., Dec. 1868 to Dec. 1869. J. W. Farmer obs. M. W. S., Jan. 1878 to Mar. 1884.

Booneville, Cooper Co., Mo. Lat. $38^{\circ} 54'$; Lon. $92^{\circ} 46'$: grade elevation about 700 ft. Chas. W. Hazell, Signal Service river observer, Aug. 1875 to Dec. 1887. The signal service standard gauge was used. T. A. Johnson, of Kemper School, obs. M. W. S., Jun. 1878 to Feb. 1881. W. M. Hoge, of the same school, M. W. S. obs., Mar. 1881 to Dec. '84.

Brunswick, Chariton Co., Mo. Lat. $39^{\circ} 27'$; Lon. $93^{\circ} 14'$: grade elevation 655 ft. G. W. Kennedy, S. S. river obs., Jul. 1874 to Apr. 1883, with S. S. standard gauge.

Carrollton, Carroll Co., Mo. Lat. $39^{\circ} 22'$; Lon. $94^{\circ} 22'$: grade elevation 680 ft. J. B. Conkling, M. W. S. obs., Aug. 1879 to Mar. 1881.

Carthage, Jasper Co., Mo. Lat. $37^{\circ} 36'$; Lon. $94^{\circ} 22'$: M. Wilson obs. M. W. S., Jan. 1878 to May 1880. D. Matthews obs. M. W. S., July 1880 to Feb. 1885. D. R. Goucher, M. W. S. obs. Mar. 1885 to Dec. '87.

- Cave Springs, Greene Co., Mo.* Lat. $37^{\circ} 20'$; Lon. $93^{\circ} 30'$: elevation 1300 ft. R. H. McCon and M. Cochrane obs. S., Jan. 1871 to Mar. '75.
- Centreville, Reynolds Co., Mo.* Lat. $37^{\circ} 25'$; Lon. $90^{\circ} 58'$: elevation — ft. M. McKenzie obs. M. W. S., Apr. 1878 to May 1887.
- Chamois, Osage Co., Mo.* Lat. $38^{\circ} 39'$; Lon. $91^{\circ} 45'$: elevation grade 525 ft. G. W. Dallas obs. M. W. S., Jan. 1879 to Dec. 1886. — Gauge exposed in the midst of a garden 40×39 ft. without any object inside the enclosure. Two walnut-trees about 25 ft. e. and s.e. having height of about 25 ft; about 10 ft. e. of these trees was a two-story building; no other high objects near. Top of gauge 18 in. above ground.
- Chillicothe, Livingston Co., Mo.* Lat. $39^{\circ} 48'$; Lon. $93^{\circ} 37'$: grade elevation 775 ft. Dr. A. S. Cloud obs. M. W. S., Jan. 1878 to Aug. 1878; W. B. Costin, May 1880 to Dec. 1881. Eugene Daly obs. M. W. S., Jan. 1882 to Jun. 1882.
- Clinton, Henry Co., Mo.* Lat. $38^{\circ} 22'$; Lon. $93^{\circ} 48'$: grade elevation 1,600 ft. J. W. Keil obs. M. W. S., Jan. 1878 to Aug. 1878. T. M. Roberts obs. M. W. S., Nov. 1879 to Aug. 1881. H. F. Dodge obs. M. W. S., Nov. 1881 to Feb. 1883.
- Conception, Nodaway Co., Mo.* Lat. $40^{\circ} 22'$; Lon. $94^{\circ} 44'$: grade elevation 975 ft. Rev. F. M. Eckstein obs. S., Nov. 1883 to Dec. 1887.
- Corning, Holt Co., Mo.* Lat. $40^{\circ} 17'$; Lon. $95^{\circ} 31'$: grade elevation 900 ft. Horace Martin obs. M. W. S., Apr. 1870 to Sept. 1883.
- Cuba, Crawford Co., Mo.* Lat. $38^{\circ} 03'$; Lon. $91^{\circ} 22'$: grade elevation 925 ft. E. A. Pinnell obs. M. W. S., Jun. 1878 to Aug. 1881.
- Curryville, Pike Co., Mo.* Lat. $39^{\circ} 0'$; Lon. $92^{\circ} 25'$: elevation — ft. W. W. Vermillion, obs. S., Feb. 1882 to Apr. 1884.
- East Prairie, Missisippi Co., Mo.* Lat. $36^{\circ} 50'$; Lon. $89^{\circ} 20'$. A. Miller obs., Jan. 1868 to Dec. 1870 S., and Jan. 1878 to Nov. 1879 M. W. S.
- Edina, Knox Co., Mo.* Lat. $40^{\circ} 10'$; Lon. $92^{\circ} 12'$. J. C. Agnew obs. S., May 1859 to Dec. 1866.
- Fayette, Howard Co., Mo.* Lat. $39^{\circ} 16'$; Lon. $92^{\circ} 45'$: elevation 700 ft. T. B. Smith obs. M. W. S., Feb. 1886 to Dec. 1887. S. S. standard gauge. A sycamore 40 ft. high stands 36 ft. s.e.; a maple 20 ft. high stands 35 ft. n.w.; a building 20 ft. high is 30 ft. e.; a closet 8 ft. high is 16 ft. s.; two or three small fruit-trees about 10 to 20 ft. distant. The rain is measured by a graduated stick.
- Forsythe, Taney Co., Mo.* Lat. $36^{\circ} 43'$; Lon. $95^{\circ} 05'$. J. J. Brown obs. M. W. S., Oct. 1878 to Aug. 1882.
- Gayoso, Pemiscot Co., Mo.* Lat. $36^{\circ} 15'$; Lon. $89^{\circ} 40'$. H. Tresenriter obs. M. W. S., Jan. 1878 to July 1881.
- Glasgow, Howard Co., Mo.* Lat. $39^{\circ} 13'$; Lon. $92^{\circ} 52'$: grade elevation 550 ft. M. B. Collins obs. M. W. S., Jan. 1878 to Feb. 1883. T. B. Smith obs. M. W. S., Mar. 1883 to May 1886. C. W. Pritchett, Director of Morrison Observatory, Jan. 1878, to Dec. 1887. The observatory gauge was made by James Green, N. Y., and "has a perfectly

circular opening of exactly 20 square inches, and is fitted with lock and key into a copper case firmly attached to a base. Several evergreens have gradually grown up at the distance of 10 to 20 ft. from the gauge; some of these are now 20 ft. high; they enclose the gauge at the centre of a circle. The gauge will be removed: it is 6 ft. above the ground.

Grant City, Worth Co., Mo. Lat. $40^{\circ} 29'$; Lon. $94^{\circ} 27'$. J. H. Houser obs. M. W. S., Jan. 1878 to April 1881.

Greenfield, Dade Co., Mo. Lat. $37^{\circ} 24'$; Lon. $93^{\circ} 50'$. S. B. Bowles obs. M. W. S., Jan. 1878 to Dec. 1886.

Hamilton, Caldwell Co., Mo. Lat. $39^{\circ} 46'$; Lon. $94^{\circ} 02'$: grade elevation 1,000 ft. M. C. Martin obs. M. W. S., June 1878 to Oct. 1879. Lilla Martin obs. M. W. S., Nov. 1879 to Dec. 1880.

Hannibal, Marion Co., Mo. Lat. $39^{\circ} 43'$; Lon. $91^{\circ} 23'$: grade elevation 480 ft. O. H. P. Lear obs. S., Jan. 1854 to May 1855. F. W. Gill obs. M. W. S., Sept. 1878 to Apr. 1886.

Harlem, Clay Co., Mo. Lat. $39^{\circ} 07'$; Lon. $94^{\circ} 38'$: grade elevation 670 ft. J. C. Evans obs. M. W. S., Jan. 1878 to Mar. 1879.

Harrisonville, Cass Co., Mo. Lat. $38^{\circ} 30'$; Lon. $94^{\circ} 25'$. J. Christian obs. S., Oct. 1863 to Sept. 1870. G. W. Houston, obs. M. W. S., June 1878 to Mar. 1885. A. J. Sharp obs. M. W. S., Aug. 1887 to Dec. 1887. Mr. Sharp's gauge is made of galvanized iron and has a diameter of 8 inches. A dip scale graduated to hundredths of an inch is used in measuring the rainfall. The gauge is on the ground, the top being 14 inches above: it is placed 30 feet n. of a house 14 ft. high.

Hematite, Jefferson Co., Mo. Lat. $38^{\circ} 11'$; Lon. $90^{\circ} 37'$: elevation 475 ft. J. M. Smith obs. S., Apr. 1868 to Mar. 1872.

Hermann, Gasconade Co., Mo. Lat. $38^{\circ} 41'$, Lon. $91^{\circ} 23'$: grade elevation 495 ft. Charles Maushund obs. Sig. Service, Feb. 1874 to Dec. 1887. Signal service standard gauge with top 5 ft. above ground.

Hermitage, Hickory Co., Mo. Lat. $37^{\circ} 56'$; Lon. $93^{\circ} 15'$. J. Moore and Dr. W. Moore obs. S., Sept. 1867 to Dec. 1869.

Hopkins, Nodaway Co., Mo. Lat. $40^{\circ} 33'$; Lon. $94^{\circ} 51'$: grade elevation 1065 ft. John Donlin obs. M. W. S.

Houstonia, Pettis Co., Mo. Lat. $38^{\circ} 53'$; Lon. $93^{\circ} 24'$.

Ironton, Iron Co., Mo. Lat. $37^{\circ} 35'$; Lon. $90^{\circ} 38'$: grade elevation 935 ft. J. W. Wilkinson obs. M. W. S., Jan. 1878 to July 1879. W. H. Delano obs. M. W. S., Aug. 1879 to Dec. 1887. The gauge is placed 40 ft. from any surrounding object, the highest being trees 30 ft. high.

Jackson, Cape Girardeau Co., Mo. Lat. $37^{\circ} 20'$; Lon. $89^{\circ} 46'$. J. W. Cannon obs. M. W. S., Jan. 1878 to Jan. 1879.

Jefferson Barracks, St. Louis Co., Mo. Lat. $38^{\circ} 28'$; Lon. $90^{\circ} 15'$: elevation 472 ft. Assis't Surg. U. S. A. obs., July 1840 to July 1862. C. E. Goddard, Surgeon U. S. A., obs., Jan. 1882 to June 1884.

Jefferson City, Cole Co., Mo. Lat. $38^{\circ} 35'$; Lon. $92^{\circ} 11'$: grade elevation 550 ft. L. C. Lohman obs. S., Apr. 1875 to Nov. 1876; May 1879 to Feb. 1885.

Kansas City, Jackson Co., Mo. Lat. $39^{\circ} 07'$; Lon. $94^{\circ} 37'$: grade elevation 775 ft. J. P. Kenmuir obs. M. W. S., Jan. 1878 to Dec. 1887. G. R. and S. W. Salisbury obs. S., Mar. 1870 to Dec. 1874. H. P. Childs obs. S., Jan. 1875 to Dec. 1877.

Kirksville, Adair Co., Mo. Lat. $40^{\circ} 10'$; Lon. $92^{\circ} 39'$: grade elevation 1000 ft. Prof. B. S. Potter obs. M. W. S. Jan. to June 1878. J. T. Reesman obs. M. W. S., July 1878 to Nov. 1881. Chs. Patterson obs. M. W. S., Apr. 1882 to Dec. 1887. Mr. Patterson's gauge is about 10 ft. above ground, and about 25 ft. w. of a building 30 ft. high. Maple-trees 25 feet high are 30 ft. n. of gauge, and evergreens 15 feet high are 25 to 30 feet n.e.

Lamar, Barton Co., Mo. Lat. $37^{\circ} 32'$; Lon. $94^{\circ} 15'$. Dr. J. W. Dunn obs., Jan. 1878 to June 1884. U. S. Signal Service obs., Mar. 1885 to Dec. 1887.

Lamonte, Pettis Co., Mo. Lat. $38^{\circ} 46'$; Lon. $93^{\circ} 22'$: grade elevation 877 ft. R. A. S. Wade obs. M. W. S., Mar. 1885 to May 1887.

Lebanon, Laclede Co., Mo. Lat. $37^{\circ} 41'$; Lon. $92^{\circ} 41'$: grade elevation 1262 ft. J. H. Wolf obs. M. W. S., Jan. 1878 to Jan. 1879. W. J. Diefenderfer obs. M. W. S., Feb. 1879 to Feb. 1880.

Lexington, Lafayette Co., Mo. Lat. $39^{\circ} 11'$; Lon. $93^{\circ} 56'$: elevation — ft. Dr. J. B. Alexander obs. M. W. S., Jan. 1878 to Sept. 1887. The gauge is on the roof of a building about 30 ft. above ground; it is above all surrounding objects.

Louisiana, Pike Co., Mo. Lat. $39^{\circ} 27'$; Lon. $91^{\circ} 05'$. J. D. Dawson obs. M. W. S., Jan. 1878 to July 1885. M. J. Hassler obs. M. W. S., Feb. 1886 to Dec. 1887. Mr. Dawson's station was on his farm some 2 miles from town. The exposure of his gauge was satisfactory, although no record of it is now at hand. Mr. Hassler's gauge is the Signal Service standard: the top is about 4 ft. above ground. A building 15 ft. high stands 25 ft. n.w., and a tree 12 ft. high stands 15 ft. w. of the gauge.

Macon City, Macon Co., Mo. Lat. $39^{\circ} 44'$; Lon. $92^{\circ} 31'$: grade elevation 880 ft. J. T. Ridgeway obs. M. W. S., Jan. 1878 to June 1884.

Mexico, Audrain Co., Mo. Lat. $39^{\circ} 10'$; Lon. $91^{\circ} 53'$: grade elevation 812 ft. J. F. Llewellyn obs. M. W. S., Jan. 1878 to Dec. 1887. The gauge consists of a cylindrical collector $2\frac{2}{3}\frac{5}{2}$ inches in diameter, terminating below in a funnel which passes into the neck of a bottle. The rainfall is measured by means of a graduated cylinder, one cubic centimeter representing an hundredth of an inch. The top of the gauge is 2 ft. above ground. One building 25 ft. high is 30 ft. e., and another 8 ft. high is 25 ft. s. of the gauge.

Miami, Saline Co., Mo. Lat. $39^{\circ} 19'$; Lon. $93^{\circ} 17'$. Dr. A. H. W. Sullivan obs. M. W. S., Jan. 1878 to Dec. 1887. The top of the gauge is 20 inches above the ground; there is no object in the vicinity of the gauge.

Mound City, Holt Co., Mo. Lat. $40^{\circ} 09'$; Lon. $95^{\circ} 17'$. Lawrence Kaucher obs. M. W. S., May 1886 to Nov. 1887.

Mine La Motte, Madison Co., Mo. Lat. —; Lon. —. J. D. Sanders obs. The gauge is a plain cylinder 8 in. in diameter and $12\frac{1}{4}$ in. high; it is mounted on a post, the top of the gauge being 4 ft. $5\frac{1}{2}$ in. above the ground. The nearest object is a slender pear-tree 18 ft. high and $9\frac{1}{2}$ ft. n. of gauge. The nearest building is 150 ft. s.w. of gauge. A small tree stands 30 feet. s.w.; these trees have grown up since 1885. The rain was measured with a 2-foot rule to the nearest 16th of an inch.

Mount Vernon, Lawrence Co., Mo. Lat. $37^{\circ} 04'$; Lon. $93^{\circ} 55'$: elevation 1,420 ft. W. Howis obs. S., July 1871 to July 1874.

Neosho, Newton Co., Mo. Lat. $36^{\circ} 52'$; Lon. $94^{\circ} 22'$: grade elevation 1,020 ft. J. M. Sherwood obs. M. W. S., Jan. 1878 to Oct. 1881.

O'Fallon, St. Charles Co., Mo. Lat. $38^{\circ} 47'$; Lon. $90^{\circ} 35'$: grade elevation 605 ft. Dr. W. C. Williams obs. M. W. S., June 1881 to Dec. '85. Gauge exposed in a garden, with no obstacles near.

Oregon, Holt Co., Mo. Lat. $39^{\circ} 59'$; Lon. $95^{\circ} 09'$: elevation 1,100 feet. William Kaucher obs. M. W. S., July 1855 to Dec. 1887. From 1855 to Mar. 1, 1867, the rainfall was approximately measured by means of buckets or other vessels, allowance being made for varying diameter. Since that time a gauge made by James Green, N. Y., has been in use. These periods have been separately reduced. The gauge is — inches in diameter and 10 inches high. It contains a false bottom 5 inches from the top, which is perforated at the centre to allow water to pass through into the lower compartment. The perforation is covered by a cap of zinc, which has openings to allow the water to pass through. The object of this arrangement is to prevent evaporation. Immediately below the false bottom is a tubulure (closed by a cork) through which the water can be discharged into a graduated cylinder which is used to measure the rainfall. The gauge is 6 ft. 4 inches above ground. It is 30 ft. east of a building 15 to 20 ft. high. A few trees are in the vicinity of the gauge, but not near enough to influence the rainfall in the gauge.

Phelps City, Atchison Co., Mo. Lat. $40^{\circ} 23'$; Lon. $95^{\circ} 40'$: grade elevation 915 ft. J. S. Wade obs. M. W. S., Mar. 1878 to July 1885.

Pierce City, Lawrence Co., Mo. Lat. $37^{\circ} 07'$; Lon. $93^{\circ} 50'$: grade elevation 1205 ft. J. J. Spilman obs. M. W. S., July 1878 to Dec. 1887.

Pleasant Hill, Cass Co., Mo. Lat. $38^{\circ} 46'$; Lon. $94^{\circ} 20'$: grade elevation 855 ft. G. C. Broadhead obs. M. W. S., Jan. 1878 to Aug. 1887.

- Near Protem, Taney Co., Mo.* The station is in Arkansas, in tp. 21, r. 17 west of the 5th principal meridian. Silas Turnbo obs. M. W. S., Sept. 1881 to Dec. 1887.
- Richland, Pulaski Co., Mo.* Lat. $37^{\circ} 51'$; Lon. $92^{\circ} 24'$: elevation 1,134 ft. S. L. Goodwin obs. S., June 1872 to June 1874.
- Rolla, Phelps Co., Mo.* Lat. $37^{\circ} 56'$; Lon. $91^{\circ} 32'$: elevation 1,150 feet. Station $3\frac{1}{2}$ miles west of the city. H. Ruggles obs. S., April 1866 to June 1876.
- Salem, Dent Co., Mo.* Lat. $37^{\circ} 38'$; Lon. $91^{\circ} 31'$: grade elevation 1,070 ft. W. H. Lynch obs. M. W. S., Mar. 1880 to May 1882.
- Savannah, Andrew Co., Mo.* Lat. $39^{\circ} 57'$; Lon. $94^{\circ} 49'$: grade elevation 1,145 ft. R. Van Buskirk obs. M. W. S., Nov. 1879 to Dec. 1887. The gauge is on a post 4 feet high. A building 75 ft. s., a tree 20 ft. high 45 ft. w., are the nearest objects.
- Sedalia, Pettis Co., Mo.* Lat. $38^{\circ} 42'$; Lon. $93^{\circ} 16'$: grade elevation 895 ft. C. L. Mitchell obs. M. W. S., Jan. to May 1878; C. G. Taylor obs. M. W. S., May 1878 to Dec. 1887. The top of the gauge is 18 in. above ground. The nearest objects are a wood-shed 8 ft. high 16 ft. east, a building 24 ft. n., and a tree 27 ft. n.w. of the gauge.
- Shelbina, Shelby Co., Mo.* Lat. $39^{\circ} 41'$; Lon. $92^{\circ} 03'$: grade elevation 795 feet. J. S. Chandler obs. M. W. S., Nov. 1879 to Dec. 1887. The top of the gauge is 12 ft. above ground. The nearest objects are a tree 15 ft. high 20 ft. w., a barn 20 ft. high 18 ft. s.s.w., and a house 15 ft. high 30 ft. n.w. of the gauge.
- Springfield, Greene Co., Mo.* Lat. $37^{\circ} 12'$; Lon. $93^{\circ} 18'$: grade elevation 1245 ft. A. Milton Lapham obs. M. W. S., Feb. 1877 to Dec. 1877; O. H. Barker obs. M. W. S., Jan. 1878 to Dec. 1880; U. S. Signal Service obs., Jan. 1882 to May 1883; Prof. E. M. Shepard, M. W. S., obs., May 1884 to June 1887; E. F. Coff, M. W. S. obs., July and Aug. 1887; U. S. Signal Service obs., Oct. Nov. and Dec. 1887. The top of Mr. Shepard's gauge is 18 in. above ground. The nearest objects are a tree 15 ft. high 30 ft. s.w., and one 25 ft. high 40 feet n.w. Mr. Coff has a U. S. Signal Service standard gauge; the top of the gauge is 15 ft. 7 in. above ground, the gauge being on the roof of a building. The nearest object is a tree 20 ft. high 48 ft. distant. The Signal Service observer has a standard gauge; it is on the roof of a building 74 ft. above ground. Mr. Barker's gauge was at the surface, the top being 18 in. above ground.
- St. Charles, St. Charles Co., Mo.* Lat. $38^{\circ} 45'$; Lon. $90^{\circ} 30'$: grade elevation 520 ft. J. R. Mudd, M.D., obs. M. W. S., Jan. 1878 to Dec. 1887. The top of the gauge is 5 ft. above ground. The nearest objects are two trees 10 ft. high about 10 ft. s.e. and n.e., a one-story stable 27 ft. w., and a house 9 ft. high 10 ft. n.w. of the gauge. Trees were set about four years ago. Previous to 1881 the gauge was exposed on an open space with no object nearer than 40 or 50 ft.

St. Joseph, Buchanan Co. Lat. $39^{\circ} 46'$; Lon. $94^{\circ} 49'$: grade elevation 845 ft. Observer not known up to Dec. 1869. From Jan. 1870 to April 1873 Smithsonian Record, Schott. Robert Gunn obs., July 1874 to Dec. 1887.

Steelville, Crawford Co., Mo. Lat. $37^{\circ} 57'$; Lon. $91^{\circ} 21'$: elevation 585 feet. E. A. Pinnell obs. M. W. S., Oct. 1884 to Dec. 1887. The gauge is on a hill side, n.e. exposure, the top being 6 feet above ground. The nearest objects are a house 30 ft. distant, the top of the house being 12 ft. above the gauge, and an apple-tree 10 ft. higher than the gauge 25 to 30 ft. s.

St. Louis, Mo., at Washington University. Lat. $38^{\circ} 38' 03''.8$; Lon. $90^{\circ} 12' 15''.3$: elevation 520 feet. F. E. Nipher, obs. M. W. S., Jan. 1878 to Dec. 1887. The gauge is in the rear yard of the dwelling-house on the s.e. cor. of 18th and Washington av. It was surrounded by houses and closed fences which protect the gauge from the wind: this, therefore, made it desirable to raise the gauge about 6 feet above ground in order to have it out of the way. When a gauge is exposed to the wind, the effect of raising the gauge above the ground is, as is well known, to cause it to lose some of the rain on account of the drifting effect of the wind. The gauge itself forms an obstacle, over the top of which the wind sweeps with a greater velocity than it would have done were the gauge not there, and the rain drifts to the leeward of the gauge. Hence gauges exposed to the wind should have the same altitude in order to be comparable. It is never good to expose a gauge on a small building in the country.

St. Louis—Signal Office. Up to Sept. 14, 1883, the gauge was exposed on the roof of the St. Louis Life Insurance Building, on 6th and Locust. Since that time it has been exposed on the roof of the Custom House. The standard gauge of the Civil Service is used.

St. Louis, Mo. Dr. George Engelmann. The observations were made at the residence of Dr. Engelmann. From 1836 to 1847 inclusive the gauge was exposed at the s.w. cor. of 2d and Chestnut sts.; from 1848 to Feb. 1868 inclusive the gauge was at the s.w. cor. of 5th and Elm sts.; from Mar. 1868 to Dec. 31, 1869, the rainfall was observed at 5th and Almond (now Valentine) sts.; from 1870 to 1881 the gauge was exposed at 3003 Locust st.

St. Louis, Mo. "Smithsonian Tables." This table of observation is from Mr. Schott's tables. The names of the observers are given on the table, but the localities of observation are not known.

St. Louis Waterworks. A. J. Chaphe and A. W. Grote obs., Jan. 1879 to Dec. 1887. M. W. S. gauge. The top of the gauge is 16 in. above the ground, with no tree nor building within 75 yds.

St. Louis, Mo. Tower Grove. ——— obs., June 1861 to June 1863.

Troy, Lincoln Co., Mo. Lat. $38^{\circ} 56'$; Lon. $90^{\circ} 59'$. J. A. Ward obs. M. W. S.

Unionville, Putnam Co., Mo. Lat. $40^{\circ} 29'$; Lon. $93^{\circ} 03'$. J. G. Hart obs. M. W. S., Jan. 1878 to May 1879; B. H. Bonfoey obs. M. W. S., Sept. 1879 to Jan. 1881.

Warrensburg, Johnson Co., Mo. Lat. $38^{\circ} 45'$; Lon. $93^{\circ} 40'$: grade elevation 870 ft. S. L. Goodwin obs. S., July 1868 to May 1875; W. L. Hedges obs. M. W. S., Jan. 1878 to Nov. 1878; Pres't Geo. L. Osborne obs. M. W. S., Dec. 1878 to Dec. 1881. The top of Mr. Osborne's gauge is about 20 ft. above ground. The nearest object is a house 15 ft. high 20 ft. n.e.

West Glaze, Camden Co., Mo. Lat. $37^{\circ} 57'$; Lon. $92^{\circ} 35'$: elevation 1450 ft. A. Y. Carleton obs. S., Jan. 1872 to Oct. 1878.

Wyaconda Prairie, Lewis Co., Mo., near Canton. G. P. Ray obs. S., Apr. 1862 to Dec. 1868.

STATIONS IN ADJOINING STATES.

Cairo, Ills. Lat. $37^{\circ} 00'$; Lon. $89^{\circ} 10'$: elevation 377 ft. U. S. Signal Service obs. Record from Jan. 1872 to Dec. 1887, but only 10 years record here published. The top of the gauge is 78 ft. above ground, the exposure being on a building.

Keokuk, Iowa. Lat. $40^{\circ} 23'$; Lon. $91^{\circ} 27'$: elevation 584 ft. U. S. Signal Service obs. Record extends from July 1871 to Dec. 1887, but only 10 years published. The top of the gauge is 60 ft. above ground.

Leavenworth, Kansas. Lat. $39^{\circ} 19'$; Lon. $94^{\circ} 58'$: elevation 842 ft. U. S. Signal Service obs. The top of the gauge is 50 ft. above ground.

Mascoutah, St. Clair Co., Ills. Lat. $38^{\circ} 32'$; Lon. $89^{\circ} 55'$. Theo. Engelmann obs. M. W. S., Jan. 1878 to Dec. 1887. The gauge is of copper and was made in St. Louis; the diameter is 7.9 in., and is made after the Signal Service pattern, a measuring-stick being used. The top of the gauge is 3 feet above ground. The nearest objects are a building 100 ft. n.w., grapevines on trellises $5\frac{1}{2}$ ft. high 10 ft. n., cedar-trees 30 ft. high 40 ft. n.w. It is fastened between two stakes which do not reach the top of the gauge.

In the tables which follow there are first given a number of stations where the record covers more than ten years. Where this record covers the ten years ending December, 1887, the means for that period are in all cases separately reduced, and were used in the construction of the normal rain charts.

Next follows a series of stations where observations were begun with the ten-year period mentioned. Finally a series of fragmentary records are given, some of which have been taken from Mr. Schott's paper, and some being the records of our own observers who have not covered the entire ten years. These series were not

used in constructing the normal maps. They were however used in constructing anew the rain maps of the individual months, in order to obtain interpolated values where observations were missing in the ten-year series.

An interesting question which suggested itself, was to compare the total amount of rainfall on the entire state, in cubic feet, with the amount of water flowing past the city of St. Louis in the Mississippi river during the same time.

In order to solve this problem, the map showing the normal annual rainfall was used. The map area of the whole State as determined by a planimeter was 0.443 square decimeter. The area of the whole state is given as 69,415 square miles. Hence if s be the planimeter area of any portion of the map of the State, the area square miles of that portion of the State represented will be

$$a = \frac{69,415}{0.443} s = 156693 s.$$

Also if r = the annual rainfall in inches over any part of the state having a map area of s , the total fall of water in cubic feet per second on that area will be

$$\begin{aligned} R &= \frac{69415 \times (5280)^2}{0.443 \times 12 \times 365 \times 86400} sr \\ &= 11543 sr. \end{aligned}$$

The area of the regions bounded by the consecutive lines of equal rainfall and the boundary lines of the State were determined by planimeter. For instance, the region between the rain lines of 42" and 44" annual fall was 0.037 square decimeters. Over this area the rainfall was assumed to be 43", as is shown in the table below. The fifth column of the table gives the number of square miles, where the rainfall has the value given in the corresponding place in column one. The total rainfall in the state in cubic feet per second is

$$\begin{aligned} R &= 11543 \sum sr \\ &= 11545 \times 16.96 \\ &= 195,800. \end{aligned}$$

The average annual rainfall in the state is

$$\frac{\sum sr}{0.443} = 38 \text{ } 28 \text{ inches,}$$

which is about the rainfall at St. Louis during the ten years.

Rainfall.	<i>r.</i>	<i>s.</i>	<i>sr.</i>	Square miles area.
Over 44"	45"	0.083	3.735	13,005
42 to 44	43	0.037	1.591	5.797
40 to 42	41	0.037	1.517	5.797
38 to 40	39	0.034	1.326	5.328
36 to 38	37	0.074	2.738	11,596
34 to 36	35	0.087	3.045	13.632
Over 38	38.2	0.014	0.535	2,194
32 to 34	33	0.043	1.419	6,738
Less than 32	31	0.034	1.054	5,328
		0.443	16.960	69,415

The river discharge at St. Louis was obtained by converting the average gauge readings for each month during the ten years into cubic feet per second, by means of the discharge-curve constructed by the Missouri River Commission. This is not quite accurate as discharge is not a linear function of gauge reading, so that fluctuations of level during the month are not properly represented. The error, however, will not be more than a few per cent., and will not at all affect the general conclusions which will be reached.

The following table gives the river discharge for each month, the unit being 1,000 cubic feet per second. Thus in January, 1878, the average flow of water was at the rate of 108,000 cubic feet per second, etc.

RIVER DISCHARGE AT ST. LOUIS.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	108	159	221	210	311	388	294	208	102	105	98	83	2,287
1879	86	78	105	162	132	213	240	149	87	81	112	90	1,535
1880	130	79	109	189	202	267	358	146	136	105	74	59	1,854
1881	84	121	262	499	506	340	318	127	112	308	435	235	3,347
1882	139	177	245	313	392	485	455	171	98	86	112	68	2,741
1883	70	198	299	223	349	565	378	198	85	94	127	79	2,665
1884	106	149	179	398	312	270	221	138	128	272	136	93	2,402
1885	156	115	235	304	312	367	275	208	237	106	114	64	2,493
1886	170	233	237	337	370	210	129	77	68	72	63	51	2,017
1887	88	149	217	210	294	179	161	81	86	70	58	53	1,556
Sum	1137	1458	2109	2845	3090	3284	2829	1503	1139	1299	1329	875	22,897

The average river discharge during the ten years ending Dec. 31, 1887, as appears from the above table, was

$$\frac{1}{12} 2,289,700 = 190.800 \text{ cubic ft. per second.}$$

The amount of water falling per second upon the whole state during the same interval was

$$195,800 \text{ cubic ft. per second.}$$

It thus appears that if all the rain which falls upon Missouri alone were to be fed into the rivers it would yield a greater flow than we have in the Mississippi river at St. Louis.

The writer has now under examination the comparison between the total rainfall on the basin draining past St. Louis, and the river discharge at this point. At present it will be sufficient to compare the total area drained with the area of Missouri. This area was measured on 59 of the monthly rain maps of the Signal Service, and found to be 0.4429 square decimeters with a probable error of ± 0.0002 . By a singular coincidence, this is the same as our map area of Missouri. The scale of the map was determined by measuring on the same maps the area of Missouri, Kansas, Nebraska, and Iowa, which was found to be 0.1718 square decimeters.

The areas of those States are given as follows:

Missouri	69,415	square miles.
Kansas	82,680	" "
Nebraska	76,855	" "
Iowa	56,025	" "
Total	284,375	" "

Hence the drainage area of the Mississippi and Missouri rivers above St. Louis is 733,120 square miles, or over ten times the area of Missouri.

FUTURE WORK OF THE SERVICE.

It is very much to be regretted that it seems to be impossible for us to make a careful study of local summer rain-storms. These are the storms which most vitally affect the agriculturist, and it is certain, that, with the general extension of the telephone among farmers, there will be developed a system of harvest storm-warnings. This matter was urged upon the Legislature of 1882,

and it has again been brought to their attention in 1889. There seems to be no probability that Missouri will be the first to inaugurate a system which will result in such profound and lasting advantages. It is simply out of the question for private citizens to carry on such work as this at their own expense, and it also seems to be out of the question to secure the organization of a state weather service by simply making a dignified presentation of the advantages of such a service.

Station Boonville, Cooper County, Mo.

Year	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1875	.....	.....	.....	.....	.....	.....	.....	3.30	.....	1.10	0.67	1.71	.....
1876	1.49	0.68	2.45	2.25	1.90	2.04	6.27	3.73	2.05	1.56	3.49	0.20	28.11
1877	*1.65	0.42	4.90	1.16	4.3	10.19	2.95	3.80	3.90	7.58	2.28	4.26	47.12
1878	1.02	4.57	5.11	4.55	7.92	3.57	2.52	2.42	1.43	1.02	0.63	2.45	37.21
1879	0.92	0.95	0.58	2.18	1.94	10.84	3.32	0.05	2.88	0.74	2.33	1.83	28.56
1880	0.90	2.08	1.10	2.93	6.80	4.88	4.82	4.38	2.04	1.62	1.79	1.24	34.58
1881	0.19	4.89	3.93	2.35	3.37	6.14	1.05	1.51	5.98	6.09	5.98	2.39	43.87
1882	1.95	6.04	2.58	6.26	6.48	7.82	5.42	2.12	2.72	8.43	2.71	2.32	54.85
1883	1.33	1.89	1.96	1.45	5.10	†8.50	2.49	0.79	0.25	6.47	1.93	1.14	33.30
1884	1.24	*2.99	3.00	1.80	5.61	4.42	6.83	2.94	10.13	3.28	2.40	2.59	47.23
1885	1.53	2.62	0.68	2.95	5.94	5.75	6.52	2.91	9.96	2.82	2.64	1.27	45.59
1886	4.00	2.14	2.00	5.19	4.16	8.19	1.05	3.48	8.96	2.21	2.77	0.78	44.93
1887	1.99	4.42	1.52	4.47	4.57	5.61	2.89	0.93	3.58	*1.60	0.79	3.00	35.37
10 yrs.	1.51	3.26	2.25	3.41	5.19	6.57	3.69	2.15	4.79	3.43	2.40	1.90	40.55
Average normals for 12 years.	1.52	2.81	2.48	3.13	4.82	6.50	3.84	2.42	4.49	3.62	2.48	1.96	40.06

* For 26 days only.

† Approximated.

Station Corning, Holt County, Mo.

Year	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1870	.....	.....	.....	2.10	.....	.....	.....	4.40	4.73	5.65	0.45	0.35	.....
1871	0.98	1.93	0.45	0.45	1.25	2.79	3.92	2.20	0.95	1.46	1.31	0.75	18.44
1872	0.50	0.30	1.29	2.63	5.38	3.30	4.37	1.00	2.30	1.53	*0.30	0.33	23.23
1873	1.25	0.15	0.40	2.40	3.75	3.63	1.55	0.75	1.10	0.90	0.20	*3.00	19.08
1874	2.43	0.74	2.12	1.10	0.45	3.90	0.75	1.10	5.25	0.35	1.75	1.05	20.99
1875	0.30	1.43	1.33	1.15	2.00	4.45	9.10	3.60	2.75	1.40	0.02	2.15	29.68
1876	0.87	0.25	6.50	5.15	4.90	5.40	3.70	3.95	2.97	1.41	2.82	0.01	37.93
1877	0.70	0.90	1.50	6.75	7.10	5.07	2.60	3.82	1.90	4.20	2.10	1.30	37.94
1878	1.25	1.37	3.45	2.86	4.68	6.30	3.23	0.40	2.33	3.75	0.87	1.03	31.52
1879	0.87	1.00	0.62	2.20	2.55	5.80	5.27	1.81	5.27	1.43	6.18	1.84	34.84
1880	0.13	0.35	0.55	2.50	4.12	3.75	4.99	12.61	2.46	2.88	1.34	0.60	36.28
1881	1.19	4.71	1.67	1.77	5.03	4.70	1.45	2.97	6.73	6.91	1.86	0.73	39.72
1882	0.23	0.73	2.15	4.80	3.63	*4.50	*2.00	1.09	0.40	5.24	1.64	1.65	28.06
1883	0.71	2.00	0.57	2.15	7.68	*16.50	3.37	1.83	1.44	*6.00	*1.00	*0.75	44.00
Normals for 13 years.	0.88	1.22	1.74	2.76	4.04	5.39	3.56	2.85	2.76	2.88	1.65	1.17	30.90

* Approximate.

† 1870 not considered in normals.

Station Hermann, Gasconade County, Mo.

Year.	January.	February	March.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.	Year.
1874	*2.02	2.94	*3.21	*3.32	*3.95	*4.92	2. S	6.19	4.38	2.50	4.16	1.32	41.80
1875	*2.02	*2.88	5.64	4.48	4.73	6.45	11.84	2.57	0.46	1.89	1.11	1.77	45.84
1876	4.24	3.09	5.98	3.18	3.28	8.11	4.75	4.21	5.21	0.61	2.75	*2.83	48.24
1877	*2.02	0.71	3.50	2.46	3.47	5.71	1.44	2.25	1.54	7.97	3.68	3.56	38.31
1878	2.08	2.18	5.24	6.52	4.71	2.15	4.86	3.50	2.81	2.04	1.46	2.51	40.06
1879	2.04	1.03	2.73	2.76	2.14	5.70	1.20	1.26	4.24	1.77	5.36	2.37	32.60
1880	1.80	1.99	1.34	3.74	3.51	3.45	3.97	3.97	2.07	2.26	2.12	1.99	32.21
1881	0.19	4.16	3.71	1.17	3.72	2.15	2.01	0.20	6.26	5.58	4.16	1.36	35.67
1882	2.51	6.66	2.15	3.65	5.57	5.11	4.35	3.16	3.38	3.99	2.53	2.42	45.48
1883	1.64	5.11	2.67	1.02	†3.50	3.80	0	0.45	1.55	0.41	3.94	3.52	27.61
1884	0.41	3.86	3.52	2.32	3.26	7.04	8.20	3.12	7.74	1.89	3.14	2.28	46.78
1885	2.97	0.89	0.85	4.47	3.91	5.04	2.96	4.71	8.73	2.45	1.78	1.90	40.66
1886	3.15	1.56	1.96	2.98	4.98	7.24	0	2.75	4.75	0.86	2.83	1.15	34.21
1887	1.16	3.30	2.42	3.39	4.61	2.01	1.94	2.85	4.48	0.28	2.42	2.13	30.54
10 years average	1.80	3.07	2.66	3.30	3.99	4.37	2.90	2.60	4.60	2.15	2.97	2.16	36.58
Normals for 14 yrs.	2.02	2.88	3.21	3.32	3.95	4.92	3.56	2.94	4.11	2.46	2.96	2.22	38.57

* Normal substituted.

† Approximated.

Oregon, Holt County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1855....							6.75	8.50	2.45	1.75	2.90	1.65	.....
1856....	2.55	2.05	1.30	3.60	3.10	4.00	6.35	6.00	2.10	1.80	1.80	1.95	36.60
1857....	1.35	1.75	2.65	1.05	3.05	3.50	3.20	6.10	3.30	3.25	3.05	1.15	33.40
1858....	1.10	3.10	2.40	5.40	8.35	7.00	6.65	2.10	0.95	2.50	2.05	1.55	43.15
1859....	2.00	2.60	3.75	6.35	11.65	6.70	4.75	4.45	2.90	1.15	1.80	1.15	49.25
1860....	1.55	1.30	0.20	0.90	3.25	4.30	2.17	2.40	2.85	0.75	1.05	2.40	23.12
1861....	5.20	1.75	1.70	1.20	7.30	7.85	3.95	3.35	3.40	3.05	1.00	1.25	41.00
1862....	2.28	1.15	2.47	6.05	4.50	0.95	2.55	5.30	3.60	2.50	1.10	1.85	34.30
1863....	1.60	2.21	1.10	2.93	3.48	5.55	4.00	6.75	1.70	2.00	2.30	3.85	37.47
1864....	1.17	0.14	2.67	3.11	3.53	1.35	2.60	6.05	4.55	2.08	2.05	0.92	30.22
1865....	0.50	3.39	1.61	6.70	2.30	9.00	5.80	7.70	2.50	1.45	0.70	1.80	43.45
Sum.....	19.30	19.44	19.85	37.29	50.51	50.20	42.02	50.20	27.85	20.53	16.90	17.87	371.96
10 years' mean...	1.93	1.94	1.98	3.73	5.05	5.02	4.20	5.02	2.78	2.05	1.69	1.79	37.20
1866....	2.81	1.01	1.52	3.37	4.43	5.75	3.90	3.26	7.61	2.38	1.60	4.99	42.63
1867....	2.08	4.89	2.95	2.48	5.84	4.10	12.24	2.95	3.20	2.10	0.40	1.40	44.63
1868....	1.00	1.55	3.60	3.43	3.50	3.51	4.22	3.02	2.87	1.68	3.05	2.17	33.60
1869....	2.06	2.51	1.28	3.31	4.42	7.49	5.74	6.90	3.28	1.24	1.49	1.46	41.18
1870....	1.00	0.03	2.30	1.99	2.70	1.27	0.76	8.44	4.20	6.14	0.35	0.45	29.63
1871....	1.27	3.11	0.56	2.14	2.13	2.30	4.50	3.40	1.13	2.42	3.16	2.42	28.54
1872....	0.20	0.67	2.63	3.85	6.50	3.84	6.71	3.97	3.55	2.46	0.26	1.11	35.75
1873....	2.76	0.29	0.76	4.15	3.79	3.33	2.18	2.05	3.18	0.79	1.13	3.00	27.41
1874....	1.86	1.10	2.38	2.85	2.39	5.49	2.73	1.86	6.15	1.47	2.83	1.22	32.33
1875....	0.55	2.25	1.80	1.31	2.14	5.13	6.45	4.98	3.58	1.42	0.18	2.51	32.30
1876....	0.72	0.48	5.35	4.61	5.25	4.30	4.70	6.04	2.62	4.02	3.18	0.15	41.42
1877....	1.50	1.01	2.99	7.32	5.20	5.00	2.45	5.36	*2.00	4.54	1.88	2.09	41.34
1878....	1.58	1.36	1.84	2.65	3.48	4.82	7.18	0.84	3.59	3.07	0.87	2.19	33.47
1879....	1.26	0.48	0.52	3.30	3.09	6.95	6.98	1.70	3.11	2.49	7.81	1.37	39.06
1880....	1.58	0.61	0.79	2.96	5.52	3.70	4.81	6.61	2.89	1.89	1.66	1.16	34.18
1881....	1.14	5.25	2.34	2.57	6.14	5.28	1.22	2.66	4.49	6.27	3.32	1.30	41.98
1882....	0.71	0.89	1.82	5.80	3.52	4.01	4.64	0.67	0.74	6.33	2.03	1.58	32.74
1883....	1.70	3.34	0.72	3.31	4.79	14.94	5.95	1.59	2.15	6.50	1.08	0.84	46.91
1884....	1.45	1.08	2.34	3.76	5.18	5.49	6.35	3.63	4.01	3.26	0.72	1.60	38.87
1885....	1.70	1.57	0.40	5.77	1.90	4.34	2.87	0.82	3.62	5.18	0.48	0.92	29.57
1886....	3.03	0.98	2.71	3.23	2.58	4.34	0.20	2.06	3.66	5.41	1.29	0.81	30.30
1887....	1.42	4.48	1.48	2.15	3.96	3.08	1.65	5.31	4.97	1.85	0.95	1.91	33.21
Sum.....	33.28	38.94	43.08	76.31	88.45	108.46	98.43	78.12	76.60	72.91	39.72	36.65	791.05
Mean for 22 yrs...	1.52	1.77	1.96	3.47	4.02	4.93	4.47	3.55	3.48	3.32	1.81	1.67	35.97
10 years' average	1.56	2.00	1.50	3.55	4.02	5.70	4.18	2.59	3.32	4.22	2.02	1.37	36.03
Normal for 32 years...	1.65	1.82	1.97	3.55	4.34	4.96	4.39	4.01	3.26	2.92	1.77	1.70	36.34

* Approximate.

1855 not considered in normals.

Rolla, Phelps Co., Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1866	*2.08	*2.21	*3.46	6.12	2.85	2.37	6.36	1.50	13.75	2.18	0.58	1.10	44.57
1867.....	1.92	3.70	2.40	*4.48	7.32	1.09	6.62	1.25	0.26	1.50	2.08	1.44	34.06
1868.....	1.33	0.29	6.59	7.10	3.39	3.25	1.87	7.15	4.85	1.34	1.47	2.56	41.19
1869.....	2.06	1.57	3.24	4.47	5.66	6.09	4.00	5.52	2.31	2.53	5.05	1.62	44.12
1870	1.18	1.06	4.64	2.64	0.68	2.73	3.99	5.64	2.33	3.56	2.55	2.44	33.44
1871 ...	3.23	2.86	2.31	1.53	4.52	2.24	4.90	5.44	0.05	2.98	1.69	1.60	33.35
1872.....	1.88	1.82	2.59	3.52	5.50	3.27	6.18	1.76	2.42	0.60	1.36	1.20	32.10
1873.....	4.61	2.30	1.92	5.17	3.14	4.01	3.42	1.38	4.51	2.19	1.04	6.02	39.71
1874... ..	1.95	3.83	3.44	3.57	3.01	3.89	2.04	2.14	2.08	2.45	4.60	1.95	34.95
1875.....	0.60	2.45	4.00	6.20	8.20	5.35	12.25	2.85	0.15	3.85	1.80	2.65	50.35
1876	6.75	1.65	5.30	5.89	4.11	9.99	....	....	....	....	....	....	....
1877.....	0.60	....	1.30	....	....	....	....	....	....	....	....	....	....
Normals for ten years. }	2.08	2.21	3.46	4.48	4.43	3.43	5.16	3.46	3.27	2.32	2.22	2.26	38.78

1876-1877 not considered in normals.

* Normals substituted.

Springfield, Greene County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1877	†1.75	1.15	4.76	6.95	8.55	15.20	2.45	6.60	1.90	7.95	4.75	3.20	65.21
1878	1.99	2.07	3.27	6.04	7.25	5.19	4.86	4.43	1.05	3.00	0.52	1.92	41.59
1879.....	1.82	0.66	1.40	2.64	2.59	2.85	1.18	1.50	0.68	0.97	4.62	4.15	25.06
1880.....	0.87	2.97	2.58	5.10	4.20	4.05	4.50	*3.00	*2.00	2.00	3.05	0.80	35.12
1881.....	*1.50	*3.00	*3.00	*2.00	*5.00	*4.50	*1.50	*2.50	*3.50	*7.00	*3.50	*2.00	39.00
1882	2.65	7.29	3.19	3.71	8.07	2.70	4.98	2.14	4.48	7.62	6.30	2.30	55.43
1883	1.05	5.65	1.68	3.11	7.30	*6.00	*7.00	*3.00	*0.40	*7.50	*2.00	*2.50	47.19
1884	*0.70	*3.20	*2.00	*4.20	5.48	2.67	9.22	3.17	3.80	1.73	3.03	7.62	46.82
1885	2.80	1.05	2.10	5.01	3.29	5.15	9.14	3.73	6.15	1.75	2.05	1.50	43.72
1886	1.55	3.43	1.50	2.90	9.30	*6.00	1.75	2.60	3.40	0.40	*1.60	0.75	35.18
1887.....	2.60	4.10	2.50	2.80	4.60	6.65	2.63	3.29	2.43	2.08	3.27	2.39	39.34
Ten yrs. averages. }	1.75	3.34	2.32	3.75	5.71	4.58	4.68	2.94	2.79	3.40	2.99	2.59	40.84
Normals for eleven years. }	1.75	3.14	2.54	4.04	5.97	5.54	4.47	3.27	2.71	3.82	3.15	2.65	43.06

† Normal substituted.

* Approximated.

St. Joseph, Buchanan County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1869.....	1.28	1.98	1.04	4.00	5.85	10.65	8.40	5.41	...	...	...	2 20	....
1870.....	0.45	0.00	1.45	2.20	3.80	....	....	8.30	....	...	...	...	....
1871.....	...	....	....	....	....	....	....	....	....	...	3.10	0.76	....
1872.....	0.20	...	....	...	2.50	4.50	6.80	6.05	1.90	2.30	....	1.49	....
1873.....	1.90	0.10	....	3.60	...	....	....	....	....	....	....	....	....
1874.....	....	....	....	....	....	...	0.80	1.55	7.10	0.60	1.71	0.74	....
1875.....	1.00	1.15	1.82	1.82	4.14	7.79	6.82	4.89	1.97	1.54	0.12	1.88	34.94
1876.....	1.42	0.18	4.77	8.30	6.18	5.42	2.40	6.36	3.02	1.84	2.93	0.05	42.87
1877.....	0.55	1.11	3.99	5.00	7.50	12.35	4.32	6.32	5.47	5.99	2.17	2.36	57.13
1878.....	2.18	1.93	2.33	2.19	4.86	5.06	4.68	3.55	3.30	2.13	1.13	1.92	35.26
1879.....	1.50	0.40	0.17	3.03	1.39	11.09	9.55	0.73	2.64	3.34	8.45	1.92	44.21
1880.....	1.64	0.48	2.32	2.38	3.81	1.05	2.12	6.98	2.07	2.00	1.48	0.79	27.12
1881.....	0.62	3.27	1.37	4.03	4.35	*6.00	1.86	2.14	3.29	12.24	2 80	1.30	43.27
1882.....	1.14	1.09	1.93	4.11	3.51	2.26	4.83	0.51	0.46	3.92	2.11	0.87	26.74
1883.....	1.17	3.33	0.50	2.48	5.29	8.16	4.15	2.28	1.35	*7.00	*1.50	*1.00	38.22
1884.....	0	*1.20	2.12	1.66	2.97	2.58	3.39	3.31	3.22	0.62	1.00	0.54	22.61
1885.....	0.29	0.40	*0.40	2.55	3.65	3.16	0.95	3.37	3.61	4.16	0.95	0.46	23.95
1886.....	*2.00	*0.50	*2.00	*2.30	4.20	5.64	0.42	0.73	5.41	3.30	0.76	*0.50	27.76
1887.....	0.16	0.48	1.50	*2.00	2.26	4.40	1.50	*6.00	3.13	1.47	1.13	0.70	24.73
Ten yrs. } averages. }	1.07	1.31	1.46	2.67	3.63	4.94	3.34	2.96	2.85	4 02	2.13	1.00	31.39
Normals } for 13 yrs. }	1.05	1.19	1.94	3.22	4.16	5.77	3.61	3.63	3 00	3.81	2.04	1.10	34.52

* Approximate.

St. Louis Signal Service Records.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1871.....	2.56	2.86	1.31	0.45	3.13	2.51	1.50	2.97	0.25	2.07	1.83	1.17	22.61
1872.....	0.64	1.15	2.43	2.77	5.97	4.28	4.59	0.93	3.38	0.55	2.01	1.70	30.40
1873.....	3.53	1.52	2.10	6.87	5.27	6.68	5.96	0.07	3.02	3.27	1.64	5.10	45.03
1874.....	3.14	3.66	4.36	3.44	3.70	2.00	5.71	4.70	2.30	1.09	2.32	1.46	37.88
1875.....	0.54	2.59	4.08	2.53	5.48	10.84	9.49	2.66	0.24	1.23	0.89	2.42	42.99
1876.....	4.75	2.86	6.90	2.25	3.13	6.43	5.18	5.03	7.63	1.66	1.74	0.18	47.74
1877.....	1.24	0.88	3 41	2.86	3.11	8.69	2.88	2.61	3.56	4.92	3.76	3.34	41.26
1878.....	2.36	1.69	2.79	6.74	4.63	2.40	3.92	4.75	3.42	3.27	1.38	3.48	40.83
1879.....	1.64	1.48	1.92	2.31	0.95	4.04	1.97	2.23	1.34	0.68	4.30	2.84	25.70
1880.....	3.83	2.65	2.51	3.31	3.44	2.46	5.17	1.53	3.10	2.09	2.67	1.80	34.56
1881.....	0.49	4.16	1.95	3.14	3.96	2.74	2.13	0.31	3.14	7.21	6.74	1.40	37.37
1882.....	2.80	8.94	3.49	3.58	4.55	4.53	3.84	2.20	1.73	2.44	3.24	1.81	43.15
1883.....	0.94	5.88	2.29	3.31	2.89	5.04	4.31	3.34	0.01	6.60	3.71	1.78	40.10
1884.....	0.79	4.43	3.00	4.15	2.68	4.52	2.86	1.21	6.04	2.48	2.30	6.18	40.64
1885.....	3.26	0.87	0.40	4.84	2.80	7.68	2.58	2.96	8.98	7.51	1.68	2.93	45.59
1886.....	3.11	1.71	3.04	2.10	7.84	7.09	0.55	2.44	9.60	0.85	3.36	2.65	44.34
1887.....	0.65	3.68	3.54	4.36	5.27	2.54	2.74	1.14	2 47	0.76	4.61	3.54	35.30
Ten yrs. } average. }	1.99	3.55	2.49	3.78	3.90	4.30	3.01	2.21	3.98	3.39	3.40	2.75	38.76
Normals } for 17 yrs. }	2.13	3.00	2.91	3.47	4.05	4.97	3.84	2.42	3.54	2.86	2.83	2.52	38.56

Jefferson Barracks, St. Louis County, Mo.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year
1840.....	...	...	...	4.39	...	1.34	4.97	12.25	5.16	5.79	1.28	0.55	...
1841.....	2.08	1.30	4.58	2.02	1.95	5.81	1.88	2.51	1.99	6.76	4.08	3.68	36.54
1842.....	0.44	3.46	2.93	4.81	4.81	2.12	1.77	1.90	0.66	2.03	1.58	1.77	29.18
1843.....	2.27	1.75	2.30	3.01	3.01	5.40	2.60	0.97	5.76	1.65	4.16	1.47	32.58
1844.....	2.19	2.33	2.50	7.27	7.27	9.78	5.23	0.71	1.80	1.06	4.46	1.19	37.27
1845.....	1.18	0.84	3.24	3.25	3.25	2.86	3.89	4.53	1.71	0.63	1.35	0.80	32.91
1846.....	3.60	1.02	1.73	3.50	3.50	4.10	0.45	2.09	3.47	0.82	1.42	10.22	36.01
1847.....	*2.40	*2.30	3.12	*4.30	*4.30	7.33	4.47	*1.00	0.85	*8.00	*8.00	0.23	42.77
1848.....	1.83	0.92	1.94	2.58	2.58	5.85	4.01	4.20	2.90	1.55	2.28	4.01	35.05
1849.....	3.41	0.37	2.77	2.10	2.10	1.52	7.70	4.72	4.84	1.85	2.02	1.52	38.58
1850.....	1.65	3.22	4.66	3.46	3.46	1.52	2.95	5.20	2.75	1.75	4.11	3.32	39.61
1851.....	0.40	5.05	1.86	3.97	3.97	5.64	4.65	7.06	0.81	2.26	0.38	1.25	36.13
1852.....	3.34	1.73	7.19	8.12	8.12	11.85	2.72	3.24	2.97	4.81	3.80	3.97	55.13
1853.....	0.57	1.51	0.85	3.52	3.52	3.19	6.90	7.08	4.20	1.10	2.40	1.23	36.08
1854.....	1.90	3.25	6.90	3.40	6.98	4.19	0.96	1.47	3.41	6.57	3.13	1.11	43.27
1855.....	4.99	0.93	3.98	1.71	4.70	2.71	7.78	3.48	4.09	4.61	4.50	*3.00	46.48
1856.....	*1.00	*3.60	*1.00	*6.00	3.95	3.80	2.15	5.93	3.20	2.41	6.07	3.02	42.13
1857.....	0.20	2.23	1.20	2.12	1.22	7.11	5.95	2.77	5.85	5.18	5.00	2.18	41.01
1858.....	3.35	1.51	1.32	2.65	6.62	6.39	7.67	1.87	4.27	6.57	3.94	3.80	49.96
1859.....	2.41	6.10	2.90	3.20	11.28	7.83	3.80	3.40	3.26	1.01	4.04	2.35	51.58
1860.....	2.03	2.13	0.98	5.62	3.91	1.06	9.61	0.65	5.09	2.16	4.63	2.21	40.08
1861.....	4.50	2.65	4.49	4.42	7.35	5.19	6.70	4.90	2.92	4.50	3.25	0.99	51.86
1862.....	2.99	1.12	1.76	...	...	4.30	11.45	...	...	...	...	...	...
1882.....	2.80	6.96	2.14	3.17	4.89	3.80	4.30	3.52	1.71	2.42	4.00	1.16	40.87
1883.....	0.59	2.79	2.95	2.99	2.09	4.90	4.73	3.37	+0.00	3.84	3.30	0.39	...
1884.....	0.55	2.10	3.00	1.90	2.64	2.60	2.68	...	...	...	...	...	...
Nominals for 21 yrs.	2.18	2.30	2.97	3.31	4.65	5.00	4.47	3.32	3.18	3.20	3.55	2.54	40.68

* Approximated.

† Estimated.

St. Louis, Mo., Smithsonian Series. Lat. 38° 37'; Lon. 90° 12'. Elevation 481 ft.

Year.	January	Febr'y.	March.	April.	May.	June.	July.	August	Sept.	October	Nov.	Dec.	Year.	Authority.
1836	.....	.....	.....	.....	.....	.....	3.66	6.51	5.90	2.59	4.20	5.02	.....	Ass't Surgeon.
1837	0.84	1.35	3.13	2.34	3.00	3.46	2.48	2.73	2.85	0.79	1.96	2.01	26.94	Dr. G. Engelmann.
1838	3.71	1.88	1.35	2.68	1.63	3.70	2.57	4.13	0.53	1.73	1.94	0.37	26.22	A. Wislizenus.
1839	1.82	2.45	2.44	4.30	7.67	7.23	5.45	2.20	2.42	3.96	2.48	2.00	44.42	B. D. Kribben.
1840	1.16	1.29	2.84	3.31	4.58	6.27	2.36	7.15	3.96	4.49	2.27	0.53	40.21	J. H. Luenemann.
1841	0.99	0.49	5.35	3.71	1.79	2.80	3.36	3.79	2.86	7.12	5.44	3.48	41.18	C. J. B. Leib.
1842	0.45	3.90	2.21	3.48	3.22	5.12	1.76	2.64	2.17	2.57	2.38	2.39	32.29	J. Stratmann.
1843	2.14	1.60	2.89	4.75	4.55	3.74	3.31	1.04	2.11	1.52	3.66	1.61	32.92	B. B. Brown.
1844	4.12	2.75	4.03	4.71	11.15	7.19	8.12	0.96	0.17	2.46	0.83	1.97	48.46	G. Prender.
1845	1.48	1.40	3.61	2.98	3.73	11.88	2.39	6.84	0.81	1.53	1.42	0.67	38.74	A. Fendler.
1846	2.59	1.73	2.16	6.22	4.86	5.07	1.03	2.70	5.56	3.52	3.15	12.23	50.82	
1847	1.95	3.34	3.31	6.12	5.15	10.04	5.34	0.82	3.06	9.41	9.34	1.01	58.89	
1848	1.41	2.61	6.09	3.04	9.02	18.02	5.46	6.53	1.15	3.37	1.91	5.50	64.11	
1849	5.88	0.56	3.15	3.36	4.55	11.08	11.53	6.55	4.89	2.48	2.73	1.86	58.62	
1850	2.02	3.55	5.26	6.76	5.44	0.82	3.96	1.63	2.97	2.58	5.45	2.38	42.82	
1851	0.45	7.03	2.44	4.00	2.54	5.00	1.58	7.69	0.58	1.51	2.39	3.43	38.64	
1852	1.10	1.80	7.83	2.11	4.82	9.04	2.20	1.86	1.31	5.00	3.02	3.19	43.28	
1853	0.55	1.90	0.84	3.46	3.25	3.41	4.13	5.21	4.14	1.03	1.18	0.71	29.81	
1854	0.91	2.76	7.30	5.95	5.47	2.70	1.31	1.64	1.40	3.57	1.70	1.19	35.90	
1855	4.44	1.04	5.02	2.41	7.89	4.26	5.61	5.69	3.50	4.07	4.98	3.07	51.98	
Normals for 9 yrs. 1836-1854	2.00	2.28	3.75	3.98	4.96	6.36	3.89	3.78	2.44	3.30	3.06	2.61	42.43	

1836 not considered in normals.

St. Louis, Mo. Dr. G. Engelmann's Record.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Win.	Spr.	Sum.	Ant.	Year
1838....	3.72	1.25	1.51	3.36	4.68	3.73	3.13	4.48	0.06	3.06	2.09	0.44	....	9.55	11.34	5.21	31.51
1839....	2.21	2.50	2.59	5.46	7.93	7.26	5.71	2.89	2.45	3.96	2.48	2.00	5.15	15.98	15.86	8.89	47.44
1840....	1.80	1.38	2.10	3.31	4.58	6.27	2.36	7.15	3.96	6.30	1.73	0.71	5.18	9.99	15.78	11.99	41.65
1841....	0.84	0.88	4.99	3.85	2.38	1.67	3.09	5.63	3.22	6.81	5.44	3.93	2.43	11.22	10.39	15.47	42.73
1842....	0.45	3.90	2.21	3.48	3.22	5.12	1.76	2.64	2.17	2.57	2.38	2.39	8.28	8.91	9.52	7.12	32.29
1843....	2.34	1.90	3.49	4.87	4.15	3.95	2.49	1.32	2.19	1.55	4.82	1.72	6.63	12.51	7.76	8.56	34.79
1844....	3.36	1.73	4.84	3.86	11.26	6.85	8.13	0.45	0.30	2.25	1.17	1.61	6.81	19.96	15.43	3.72	45.81
1845....	1.83	1.07	3.18	2.28	4.22	10.01	4.75	6.23	1.03	1.16	1.10	0.93	4.51	9.88	20.99	3.29	37.99
1846....	2.98	1.27	1.27	4.84	3.75	5.21	0.84	4.73	4.84	2.71	2.11	10.90	5.18	9.86	10.78	9.66	45.45
1847....	2.12	3.58	2.28	3.98	4.36	8.61	5.37	0.90	3.26	8.74	8.63	0.89	16.60	10.62	14.88	20.63	52.72
1848....	1.86	2.27	6.61	3.16	8.10	17.07	5.37	9.74	1.12	2.41	1.91	5.74	5.02	17.87	32.18	5.44	65.36
1849....	4.18	0.56	2.70	2.64	2.71	6.46	9.40	5.15	5.81	2.17	2.11	1.82	10.48	8.05	21.01	10.09	45.71
1850....	1.94	4.10	5.63	7.68	7.47	1.47	4.83	2.10	3.74	2.71	6.24	2.59	7.86	20.78	8.40	12.69	50.50
1851....	0.61	6.74	3.14	4.70	2.83	6.19	1.77	8.97	0.49	1.51	1.99	3.90	9.94	10.67	16.93	3.99	42.84
1852....	0.99	2.12	7.67	2.28	5.19	10.25	3.36	1.60	1.47	5.26	3.29	3.48	7.01	15.14	15.21	10.02	46.96
1853....	0.52	1.67	0.79	3.24	3.64	3.23	4.10	5.48	4.67	0.96	1.51	1.08	5.67	7.67	12.81	7.14	39.89
1854....	1.18	3.11	7.49	7.60	6.30	3.21	0.92	1.80	1.44	4.15	1.94	1.49	5.37	21.39	5.93	7.53	40.63
1855....	4.66	0.70	2.89	2.65	7.46	4.27	5.17	6.53	3.89	3.89	5.16	3.10	6.85	13.00	15.97	12.94	50.37
1856....	1.03	3.64	1.06	6.35	3.03	1.24	4.61	6.32	3.51	2.10	4.90	4.29	7.77	10.44	12.17	10.51	42.08
1857....	0.41	7.74	1.80	1.72	4.81	3.71	2.82	4.15	3.18	3.02	3.80	1.87	12.44	8.33	10.68	10.00	39.03
1858....	3.42	2.12	3.96	6.07	10.64	6.69	8.03	2.87	3.86	7.73	4.92	8.52	7.41	20.67	17.59	16.51	68.83
1859....	2.32	5.35	7.32	4.89	6.60	11.02	5.54	2.93	4.44	1.80	5.43	3.76	16.19	18.31	19.49	11.67	61.40
1860....	1.80	2.60	1.16	2.03	2.29	6.58	2.97	2.96	2.11	1.58	1.63	2.08	8.16	5.48	12.51	5.32	29.79
1861....	1.16	2.01	7.38	3.18	4.39	4.96	2.04	3.44	4.14	2.85	1.39	1.09	5.25	14.95	10.44	8.38	38.03
1862....	4.01	0.80	4.11	4.82	2.51	2.85	3.61	1.32	6.27	3.73	3.59	6.38	5.90	11.44	7.78	13.59	44.00
1863....	4.11	3.99	3.02	1.55	2.68	3.16	2.51	6.93	1.56	4.76	2.15	4.03	14.48	7.25	12.60	8.47	40.45
1864....	2.74	0.82	1.71	5.58	3.90	0.41	3.60	4.91	2.82	3.15	5.25	2.72	7.59	11.19	8.92	11.22	37.61
1865....	0.87	3.75	8.61	3.31	5.66	5.21	7.94	1.96	2.60	3.33	0.00	3.63	7.34	17.58	15.11	5.93	46.87
1866....	4.16	2.24	2.80	1.56	2.24	5.59	3.67	5.16	10.53	2.01	1.37	1.87	10.63	6.60	14.42	13.91	43.20
1867....	2.28	4.81	2.37	0.53	8.26	5.64	3.71	2.29	0.17	1.31	2.74	3.65	8.96	11.16	11.64	4.22	37.76
1868....	1.71	0.55	7.66	7.08	3.96	1.58	2.03	8.53	5.25	2.11	2.04	3.09	5.91	18.70	12.14	9.40	45.59
1869....	2.02	2.49	4.24	4.61	3.60	6.25	2.49	5.51	1.70	3.42	7.48	3.16	7.60	12.45	14.25	12.60	46.97
1870*....	2.00	1.00	2.00	2.55	1.93	1.38	1.59	6.55	1.14	3.35	1.94	2.76	6.16	6.48	9.52	6.43	28.19
1871....	3.60	2.64	1.14	0.25	3.40	2.87	1.14	3.00	0.02	1.75	1.21	0.85	9.00	4.79	7.01	2.98	21.87
1872....	0.79	1.69	1.70	2.85	6.57	4.38	5.03	0.36	2.84	0.29	1.89	1.76	3.33	11.12	9.97	5.02	30.35
1873....	3.58	1.44	2.07	5.29	4.45	6.89	6.18	0.04	2.38	2.62	1.39	4.43	6.78	11.81	13.11	6.39	40.76
1874....	2.47	2.23	3.75	2.80	3.48	2.00	5.30	4.01	2.33	0.84	2.37	1.45	9.13	10.03	11.31	5.54	33.03
1875....	0.54	2.61	3.28	2.80	4.55	10.09	10.00	2.54	0.33	1.30	0.91	2.25	4.60	10.63	22.63	2.54	41.23
1876....	4.44	2.91	6.79	2.11	2.84	5.76	5.78	5.55	7.32	*2.60	11.55	1.19	9.64	11.74	17.09	21.47	58.84
1877....	1.41	0.63	4.07	2.43	2.59	8.50	2.37	3.17	2.20	4.16	3.06	2.61	3.23	9.09	14.04	9.42	37.20
1878....	2.44	1.85	2.50	6.17	4.88	1.88	2.59	5.79	3.61	3.07	0.20	3.03	5.48	13.55	10.26	6.88	38.01
1879....	1.65	1.38	1.81	2.62	0.96	3.83	1.85	2.23	1.34	0.43	4.05	3.15	6.06	5.39	7.91	5.82	25.30
1880....	3.27	2.60	3.10	3.22	2.70	1.13	....	....	....	....	....	....	9.02	....	....	....	....
1881....	0.39	5.41	2.06	2.73	4.34	....	....	....	....	....	....	....	....	....	....	....	....
Average 42 years	2.19	2.54	3.60	3.72	4.60	5.22	4.14	4.07	2.90	2.96	2.89	2.86	7.59	11.92	13.43	8.98	41.92

1880 and 1881 not included.

Stations having a Record for 10 Years ending Dec. 31, 1887.

Cairo, Ills. Signal Service Record.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878....	3.05	1.94	2.97	5.61	4.41	4.61	2.81	3.45	2.99	2.59	3.80	3.53	41.76
1879....	2.81	2.03	2.95	2.93	2.79	8.70	1.37	7.05	0.93	3.87	3.25	6.63	45.31
1880....	4.56	5.01	4.52	3.25	4.64	2.92	4.34	2.61	4.55	6.96	3.98	2.22	49.56
1881....	3.56	4.97	1.33	3.62	2.44	1.81	0.18	0.11	2.74	2.74	4.98	3.70	32.18
1882....	6.35	10.14	4.22	4.14	10.22	3.34	5.25	3.46	3.28	2.57	5.96	2.65	61.58
1883....	2.74	8.52	2.15	5.64	3.85	6.11	7.95	1.73	0.34	6.97	4.36	2.18	52.54
1884....	2.32	5.58	4.20	3.65	4.57	2.95	7.34	2.74	5.02	1.89	2.41	8.99	51.66
1885....	3.49	1.48	1.08	1.43	3.21	4.63	0.82	2.40	4.76	2.89	2.79	3.01	31.99
1886....	3.82	2.54	2.84	6.64	2.98	4.87	1.01	2.84	2.52	0.45	5.73	1.74	37.98
1887....	2.15	4.60	2.18	2.09	1.37	2.34	1.42	1.10	1.67	0.38	3.33	4.12	26.75
Average	3.48	4.68	2.84	3.90	4.05	4.23	3.25	2.75	2.88	3.13	4.06	3.88	43.13

Carthage, Jasper Co., Mo.

Date.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.20	2.99	2.03	5.29	6.47	4.00*	4.61	0.52	3.15	2.10	1.00	1.96	36.66
1879	1.18	1.55	1.00	1.76	3.31	5.00*	2.00*	4.00*	1.27	1.85	3.44	2.35	28.71
1880	0.85	2.00*	1.82	4.45	4.50	2.50*	4.14	4.44	5.00	1.84	1.09	1.57	34.20
1881	1.44	3.15	2.43	1.61	3.76	5.00*	1.50*	1.43	3.95	8.55	4.36	2.05	39.23
1882	1.50	5.12	3.75	3.63	3.27	4.56	5.40	1.28	3.26	5.93	2.60	0.89	41.19
1883	1.38	4.78	0.87	1.47	5.10	5.15	12.18	6.42	0.40	11.76	2.01	2.14	53.67
1884	1.60	3.72	1.20	4.40	3.32	3.73	5.28	1.95	3.38	3.67	1.65	6.91	40.81
1885	2.30	1.15	1.66	7.54	4.40	5.36	4.31	4.30	4.73	1.09	0.84	1.69	39.37
1886	2.30	1.59	1.60	1.54	1.12	5.60	10.38	3.82	3.89	0.88	1.74	0.90	35.36
1887	0.70	3.16	2.62	2.08	6.06	7.23	2.32	6.14	2.71	3.40	1.57	2.08	40.07
Average.	1.55	2.92	1.90	3.38	4.13	4.81	5.21	3.43	3.21	4.11	2.03	2.25	38.93

* Approximated.

Centreville, Reynolds County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.00*	1.50*	4.00*	6.57	4.87	2.20	7.95	4.85	3.21	2.63	2.13	3.70	45.61
1879	1.88	1.60	0.92	1.43	2.21	7.91	3.50	10.27	1.44	1.78	6.82	3.01	42.77
1880	3.57	4.21	6.11	3.29	2.23	5.32	4.15	0.98	4.25	2.78	5.07	1.97	43.93
1881	1.00	5.22	3.82	2.08	4.42	5.17	0.75	0.71	2.11	4.77	4.95	2.15	37.15
1882	2.69	6.44	2.91	1.18	8.06	2.94	7.87	3.83	1.94	4.12	4.96	2.13	49.07
1883	2.23	6.95	1.62	4.25	6.45	6.40	5.77	5.84	0.64	7.50	5.55	1.82	55.02
1884	1.61	6.21	2.48	2.90	1.06	5.00*	7.00*	1.06	1.43	0.43	1.30	7.22	37.70
1885	2.14	0.85	1.49	2.00	3.20*	10.73	5.53	1.61	6.26	1.71	2.72	2.85	41.09
1886	2.10	2.11	3.87	4.26	2.89	5.31	0.05	5.22	4.73	0.96	5.83	2.42	39.75
1887	1.98	5.32	1.90	1.56	5.67	2.70*	3.80*	3.00*	1.30*	1.00*	3.50*	2.70*	34.43
Mean	2.12	4.04	2.91	2.95	4.11	5.37	4.64	3.74	2.73	2.77	4.28	3.00	42.65

* Approximated.

Chamois, Osage County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	*2.00	*2.50	*4.00	*6.30	*4.70	*2.20	*4.00	*3.20	*2.30	*1.50	*1.00	*3.27	36.97
1879.....	1.80	1.11	1.73	3.24	1.85	6.87	2.59	0.49	5.20	2.75	3.27	2.43	33.33
1880.....	1.01	1.79	0.81	3.56	3.27	2.12	1.71	0.98	0.99	1.75	1.29	1.80	21.08
1881.....	0.09	4.31	2.51	2.22	3.59	3.86	0.24	*0.25	8.93	5.03	7.34	1.52	40.89
1882.....	1.92	8.98	1.98	3.96	7.33	3.18	2.55	1.21	3.00	4.03	8.38	2.00	43.52
1883.....	1.24	5.32	2.50	1.29	3.58	5.34	2.76	0.63	0.35	8.70	4.00	1.61	37.32
1884.....	0.88	5.12	4.34	3.51	2.30	3.94	4.30	3.30	5.62	1.84	2.60	4.37	42.12
1885.....	2.95	0.75	0.51	4.49	3.36	7.94	5.93	5.13	7.74	1.55	0.60	1.86	42.81
1886.....	3.03	0.74	1.23	2.62	6.23	7.66	*	2.12	3.46	1.00	3.00	0.75	31.84
1887.....	*1.50	*3.00	*2.30	*3.50	*4.50	*2.70	*3.00	†2.90	*4.00	*1.00	*2.20	*2.80	33.40
Average	1.64	3.36	2.19	3.47	4.07	4.58	2.71	2.02	4.16	2.92	2.97	2.24	36.33

* Approximated.

Glasgow, Howard County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	1.35	3.37	4.35	2.72	3.73	0.96	2.78	1.30	2.02	1.66	0.50	3.82	28.56
1879.....	0.99	0.47	0.51	1.64	1.69	7.74	3.89	0.23	3.31	1.69	2.25	1.68	26.09
1880.....	0.91	1.83	1.29	1.07	6.00	1.12	3.81	3.95	5.25	1.50	1.67	1.26	29.66
1881.....	0.01	5.45	3.39	2.06	4.56	6.18	2.33	*0.75	4.05	5.60	2.25	1.80	38.43
1882.....	1.26	3.38	*2.75	2.65	4.03	*5.25	4.30	1.53	4.24	4.78	4.13	1.27	39.57
1883.....	1.53	4.00	1.68	1.30	5.59	11.00	3.23	0.50	0.39	7.93	1.50	1.22	39.89
1884.....	1.25	2.23	2.36	3.03	3.29	3.28	10.95	2.98	8.64	4.85	2.27	3.37	48.50
1885.....	2.16	0.94	0.34	5.31	2.00	6.50	3.36	6.00	5.96	3.47	1.15	1.23	38.42
1886.....	2.00	1.29	2.06	3.35	1.69	*7.00	*0.40	*3.00	*4.80	*2.00	*1.70	*0.40	29.69
1887.....	*2.00	*3.00	*1.50	*3.30	*2.70	*6.00	*3.00	*1.70	*5.20	*1.90	*1.50	3.70	35.50
Average	1.35	2.60	2.02	2.64	3.53	5.50	3.81	2.19	4.39	3.54	1.89	1.97	35.43

* Approximated.

Glasgow, Morrison Observatory, Howard County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	1.12	3.13	4.38	2.71	3.99	2.79	0.83	1.39	1.95	1.76	0.46	4.20	28.71
1879.....	0.75	0.12	0.43	1.52	1.57	7.59	3.36	0.47	3.28	1.45	1.29	1.82	23.65
1880.....	0.67	1.67	1.24	0.99	5.76	1.06	3.78	6.08	2.67	1.50	1.59	0.68	27.69
1881.....	0.00	4.51	3.24	2.29	4.73	5.46	1.74	1.55	3.66	4.88	1.29	1.68	35.03
1882.....	0.78	3.05	2.68	2.45	3.94	4.77	4.60	1.71	4.06	4.19	3.96	1.14	37.33
1883.....	1.41	3.47	1.44	1.07	5.77	8.04	3.35	0.37	0.49	7.58	1.28	0.94	35.21
1884.....	1.17	2.01	2.30	3.40	3.30	3.02	12.16	2.76	8.38	4.53	1.98	2.95	47.96
1885.....	1.84	0.65	0.00	6.48	2.23	6.58	3.16	3.56	6.12	3.63	1.23	1.42	36.90
1886.....	2.16	0.90	2.11	4.02	1.77	5.30	0.40	2.69	4.85	2.22	0.92	0.41	27.75
1887.....	1.30	2.46	0.96	3.34	2.65	5.33	1.69	1.75	4.72	1.42	1.06	3.72	30.40
Mean.....	1.12	2.20	1.88	2.83	3.57	4.99	3.51	2.23	4.02	3.32	1.51	1.90	33.06

Glasgow, Morrison Observatory, Howard County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1877.....										*4.87	2.51	3.21	.....

* Not considered in average.

Greenfield, Dade County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.20	2.10	2.50	5.30	7.00	3.90	3.20	2.50	1.40	1.80	1.20	2.40	34.50
1879	1.08	1.50	1.15	0.95	5.27	6.15	*2.00	2.85	0.70	1.05	1.35	2.05	26.10
1880	0.45	1.25	0.85	4.10	4.70	1.85	4.90	5.80	1.95	1.70	1.25	1.00	29.80
1881	1.70	1.80	2.10	0.65	3.30	4.00	1.70	2.55	4.80	8.30	3.40	*1.70	36.00
1882	1.60	5.55	2.70	2.59	3.10	2.00	3.60	0.10	6.00	2.80	2.50	0.97	33.51
1883	0.30	2.90	0.60	1.05	2.60	*6.50	9.00	1.70	0.00	5.20	1.20	1.40	32.45
1884	0.60	1.10	1.30	6.50	2.50	1.90	6.60	0.50	4.00	2.50	2.10	3.80	33.40
1885	0.90	0.60	0.50	4.50	5.20	4.60	8.00	7.00	7.60	2.10	0.60	1.00	42.60
1886	1.60	0.80	1.40	1.20	5.50	6.30	4.50	3.70	4.70	1.10	1.40	1.50	33.70
1887	*1.00	3.00	*1.80	*4.00	*3.00	*6.20	*2.70	*3.50	*3.50	*2.50	*2.00	*2.20	35.40
Average	1.04	2.06	1.49	3.08	4.22	4.34	4.62	3.02	3.47	2.91	1.70	1.80	33.75

* Approximated.

Ironton, Iron County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.75	0.97	3.83	5.90	5.98	2.26	3.82	2.85	3.15	3.90	1.69	4.05	41.15
1879	1.60	1.63	0.97	1.43	1.35	6.73	3.47	8.30	2.02	2.82	8.72	3.84	42.88
1880	5.30	5.45	5.97	4.32	4.72	3.75	4.72	1.80	4.18	2.80	5.02	2.50	50.53
1881	1.17	5.69	2.25	3.30	3.95	7.00	0.95	4.25	3.55	4.30	5.90	2.35	44.66
1882	3.45	5.80	2.80	2.45	9.55	3.95	3.55	1.99	2.55	3.60	4.35	2.50	46.54
1883	2.60	7.45	2.32	4.85	7.30	6.90	5.10	2.15	0.75	8.50	6.80	1.92	56.64
1884	1.85	5.80	3.00	*2.50	6.30	5.75	7.00	1.20	1.95	0.95	2.15	7.47	45.92
1885	3.10	0.65	1.55	2.95	3.25	9.15	4.45	3.30	4.55	3.60	3.00	3.60	43.15
1886	1.90	1.65	3.50	3.60	3.30	4.20	1.30	1.45	4.90	1.45	5.50	2.40	35.15
1887	2.10	3.75	2.40	2.05	5.60	2.60	4.15	2.61	1.10	0.70	3.55	2.70	33.31
Average	2.58	3.88	2.86	3.34	5.13	5.23	3.85	2.99	2.87	3.26	4.67	3.33	43.99

* Approximated.

Kansas City, Jackson County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	1.33	2.52	2.63	2.99	4.03	2.26	3.82	1.26	2.73	0.75	0.51	3.34	28.17
1879.....	0.10	0.36	1.19	3.89	1.70	8.50	4.11	0.49	3.18	4.06	4.97	2.18	34.73
1880.....	2.35	1.31	1.72	3.16	3.80	3.23	2.97	12.26	3.03	2.95	2.30	0.00	39.08
1881.....	0.00	4.11	2.32	1.86	2.86	5.22	2.21	2.59	6.15	4.59	3.23	1.02	36.16
1882.....	0.35	2.05	1.30	2.83	4.21	2.76	3.21	0.95	4.31	3.93	2.51	0.79	29.20
1883.....	0.85	3.44	1.08	1.50	6.47	10.95	6.93	1.28	0.82	7.78	2.04	0.81	43.95
1884.....	1.20	1.85	2.69	3.36	2.52	4.69	4.73	6.76	6.90	4.30	1.07	1.95	42.02
1885.....	1.41	0.96	0.42	6.80	2.82	7.72	4.37	8.14	8.99	4.17	2.93	0.79	49.52
1886.....	0.69	0.23	2.01	1.26	4.73	3.37	0.00	0.68	2.61	1.43	1.27	0.76	19.04
1887.....	0.88	2.14	1.71	1.88	2.29	6.17	1.87	6.54	5.35	2.95	1.06	2.55	35.39
Average	0.92	1.90	1.71	2.95	3.54	5.49	3.42	4.09	4.41	3.69	2.19	1.42	35.73

Keokuk, Iowa. Signal Service Record.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	0.17	2.95	3.78	2.31	3.47	3.93	2.37	5.27	1.36	2.31	1.93	1.95	31.80
1879.....	0.50	0.53	1.71	1.56	2.27	2.63	1.98	4.57	1.12	0.28	3.91	1.45	22.51
1880.....	3.91	1.94	1.83	4.79	5.92	3.06	2.25	3.81	3.21	2.02	1.13	0.67	34.54
1881.....	0.50	2.58	2.42	3.12	1.35	8.70	3.08	0.86	4.10	8.01	2.59	1.70	39.01
1882.....	1.07	1.54	3.30	3.22	7.11	9.45	4.23	3.09	1.52	2.71	2.25	1.75	41.24
1883.....	1.24	6.15	1.07	2.97	4.87	5.87	3.14	1.32	1.76	6.95	2.09	1.20	38.63
1884.....	0.85	1.88	3.37	1.31	3.16	4.03	2.30	2.74	4.25	3.35	1.72	3.91	32.87
1885.....	2.44	1.10	0.17	3.33	2.59	6.97	2.29	5.98	3.77	3.59	0.88	1.96	35.07
1886.....	2.08	1.40	2.25	1.62	4.49	2.86	0.65	5.90	3.95	2.38	1.15	1.03	29.76
1887.....	1.48	5.19	0.76	1.00	2.54	1.55	1.57	2.38	3.13	1.98	1.18	2.73	25.49
Average	1.42	2.53	2.07	2.52	3.78	4.90	2.39	3.59	2.82	3.36	1.88	1.83	33.09

Kirksville, Adair County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	0.20	1.98	3.00	2.82	4.83	0.42	1.26	4.18	1.33	1.41	1.20	2.30	24.93
1879	0.48	0.40	1.37	1.98	2.48	7.34	4.76	4.43	2.72	1.38	3.65	1.37	32.36
1880	3.77	1.70	3.02	1.50	2.57	1.34	2.82	4.10	1.77	1.67	2.03	0.57	26.86
1881	0.00	4.72	3.57	2.70	0.78	8.38	1.90	0.98	5.05	11.30	2.93	*1.50	43.81
1882	*0.50	*1.70	*3.00	5.13	4.63	12.61	5.95	4.07	1.85	2.10	2.31	1.58	45.43
1883	1.06	3.76	0.69	1.23	4.78	7.51	3.15	3.20	1.12	5.57	1.68	1.09	34.84
1884	0.50	1.33	1.87	2.29	4.25	3.02	4.24	4.54	4.83	3.96	1.08	2.53	34.44
1885	2.00	0.70	0.01	3.34	2.77	4.49	2.45	3.52	1.58	4.57	0.25	0.55	26.23
1886	1.77	0.67	1.08	0.98	4.95	1.73	0.00	2.90	4.10	2.80	1.00	0.22	22.20
1887	1.70	3.62	0.57	0.98	1.17	2.77	3.34	3.88	3.11	2.22	0.63	2.20	26.19
Average	1.20	2.06	1.82	2.29	3.32	4.96	2.99	3.58	2.75	3.70	1.68	1.39	31.73

* Approximated.

Lamar, Barton County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.10	2.22	3.88	4.76	6.61	3.09	4.47	2.24	1.40	0.88	0.59	3.09	34.33
1879	1.85	1.09	0.75	1.24	4.36	5.01	2.16	5.71	1.55	2.61	4.45	2.76	33.54
1880	0.30	2.12	1.57	5.07	5.93	*2.50	5.02	7.20	2.52	1.20	1.22	1.00	35.65
1881	1.20	4.48	2.45	0.69	3.62	3.57	1.40	1.76	5.90	4.77	3.64	*2.20	35.68
1882	2.13	7.97	2.31	3.78	5.51	4.49	5.15	1.75	5.00	4.85	2.60	0.95	46.49
1883	1.33	3.36	1.85	0.91	4.25	5.12	7.55	1.57	0.25	7.83	1.41	2.05	37.48
1884	0.69	*2.00	*1.50	4.49	2.93	1.46	*6.00	*1.70	*4.20	*2.50	*1.70	*5.00	34.17
1885	*1.00	*0.70	1.27	6.64	5.02	3.12	7.75	7.04	13.24	1.57	0.49	0.91	48.75
1886	2.91	1.22	1.94	1.78	3.59	4.73	2.19	4.37	5.96	2.29	1.68	0.82	33.48
1887	0.63	1.78	2.63	4.78	2.74	6.90	2.87	3.85	4.01	1.94	1.50	2.09	35.72
Average	1.31	2.69	2.02	3.41	4.46	4.00	4.46	3.72	4.40	3.04	1.93	2.09	37.53

* Approximated.

Leavenworth, Kas.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.34	2.94	2.35	2.86	5.28	5.27	3.08	3.31	2.64	1.16	1.76	2.16	35.15
1879	1.16	0.54	0.32	0.42	3.04	9.90	4.99	0.18	3.41	4.25	7.85	2.34	38.40
1880	2.00	1.40	2.22	1.38	5.01	1.69	6.86	7.06	2.78	3.69	2.40	0.40	36.89
1881	0.44	4.84	2.21	1.86	3.65	5.27	1.72	2.74	6.89	5.73	3.42	1.18	39.95
1882	0.83	1.17	1.15	4.15	2.53	5.06	3.44	0.83	0.95	2.86	1.87	1.13	25.97
1883	0.75	2.92	1.05	0.97	7.33	10.84	3.58	1.95	1.57	8.31	2.02	0.65	41.94
1884	0.97	1.42	3.70	4.74	4.79	3.33	9.43	4.65	5.38	3.41	1.42	1.48	44.72
1885	1.47	0.87	0.31	6.63	5.89	4.00	4.56	5.20	7.65	4.23	1.86	0.97	43.64
1886	1.60	0.61	1.35	1.47	4.71	4.93	0.55	0.73	2.75	1.80	1.10	0.65	22.25
1887	1.27	1.94	1.59	1.99	3.07	5.43	1.36	7.11	5.73	3.87	1.14	2.55	37.05
Average	1.28	1.87	1.62	2.65	4.53	5.57	3.96	3.38	3.98	3.93	2.48	1.35	36.60

Lexington, Lafayette County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1878	1.34	3.57	2.58	3.42	3.26	2.77	4.60	1.20	1.78	1.58	0.50	4.00	28.60
1879	1.05	0.48	1.07	1.94	2.65	10.53	6.89	0.44	3.02	3.12	3.94	2.63	37.76
1880	2.29	1.62	1.85	3.63	3.63	0.65	3.70	5.14	4.37	2.24	2.51	0.97	32.60
1881	0.34	4.29	2.67	2.12	3.99	5.94	2.10	2.24	6.43	5.09	2.03	2.38	39.62
1882	0.99	2.50	1.75	3.87	4.72	5.76	4.83	2.71	3.38	3.94	4.10	1.35	39.90
1883	1.75	3.74	1.40	0.68	6.23	10.72	6.86	2.87	1.25	5.42	1.56	0.88	43.36
1884	1.70	1.51	1.94	2.87	4.22	1.85	7.26	3.95	6.84	4.50	1.51	2.45	40.60
1885	1.87	1.39	0.42	5.90	4.67	8.73	5.72	5.06	6.51	2.71	1.37	1.15	45.50
1886	1.79	1.08	1.15	2.74	3.59	4.66	0.31	1.19	3.36	1.72	1.63	0.51	23.73
1887	1.68	2.46	1.09	2.44	2.24	4.99	3.17	4.80	5.38	2.32	0.95	4.26	35.78
Average	1.48	2.26	1.59	2.96	3.92	5.66	4.34	2.96	4.23	3.26	2.01	2.06	36.77

Louisiana, Pike County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	1.32	3.15	4.52	3.04	6.01	1.05	3.40	1.65	1.00	2.15	1.40	2.55	31.24
1879.....	0.95	0.30	1.18	3.40	0.92	1.70	2.10	2.45	1.65	2.05	3.20	1.60	21.50
1880.....	0.80	1.45	1.72	1.24	6.37	*3.00	1.10	2.85	1.45	0.90	1.90	1.40	24.18
1881.....	0.00	3.70	3.95	1.10	1.37	7.40	1.00	0.00	3.65	8.95	3.95	3.40	38.47
1882.....	1.65	6.55	3.27	2.82	4.05	7.42	1.80	2.17	1.55	4.72	2.87	2.15	41.02
1883.....	1.65	5.75	1.35	1.60	4.27	9.75	2.75	1.35	0.19	3.92	1.82	0.61	35.01
1884.....	1.06	3.70	2.35	1.07	3.36	4.86	5.28	3.55	7.60	1.82	1.30	3.20	39.15
1885.....	2.88	1.00	0.10	6.00	2.95	4.39.	1.75	*5.00	*4.70	*3.00	*1.50	*1.30	34.57
1886.....	*3.00	0.59	1.72	2.51	2.72	4.78	0.01	5.12	8.46	0.65	1.91	1.45	32.92
1887.....	1.41	2.97	1.45	2.70	3.15	1.97	1.37	1.28	3.17	0.41	2.15	3.62	25.65
Average	1.47	2.92	2.16	2.55	3.52	4.63	2.06	2.54	3.34	2.86	2.20	2.13	32.37

* Approximated.

Mascoutah, St. Clair County, Ills.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	2.47	1.83	2.61	4.67	5.18	1.26	3.49	1.62	2.98	3.36	0.71	4.00	34.18
1879.....	1.24	1.64	2.62	1.00	1.08	5.31	4.05	2.72	1.35	1.31	6.10	3.06	31.48
1880.....	2.81	3.45	4.25	3.91	5.16	2.23	2.61	0.85	1.99	2.46	3.32	2.00	35.04
1881.....	0.27	4.72	2.18	2.09	2.63	2.39	1.64	0.54	1.65	6.04	6.65	1.55	32.35
1882.....	2.87	6.54	3.29	2.16	4.29	4.94	4.84	2.67	2.73	3.55	3.04	1.84	42.76
1883.....	0.95	6.32	2.67	3.40	3.18	6.69	3.97	2.36	0.03	7.81	3.53	2.18	43.09
1884.....	1.12	4.88	3.48	2.89	4.03	5.50	2.15	2.56	4.44	1.91	2.40	5.38	40.74
1885.....	2.66	1.28	0.56	3.83	3.53	3.87	3.01	4.35	5.46	5.93	3.04	3.82	41.34
1886.....	1.94	1.30	3.21	3.99	5.81	5.00	0.37	2.66	7.25	0.76	3.27	2.53	38.09
1887.....	0.96	3.90	5.03	3.29	3.91	1.96	2.27	2.51	2.67	1.11	6.34	3.50	37.45
Average	1.73	3.59	2.99	3.12	3.88	3.91	3.84	2.28	3.06	3.42	2.84	2.99	37.65

Mexico, Audrain Co., Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.94	3.18	3.94	3.82	4.47	3.46	1.40	5.58	1.08	2.46	1.26	3.28	35.87
1879	1.30	0.63	1.31	2.67	1.64	6.01	4.04	0.58	2.45	0.88	5.83	1.61	28.95
1880	1.23	1.64	1.32	1.89	6.35	3.00	4.87	3.21	1.95	1.10	1.97	1.36	29.89
1881	0.26	4.53	4.18	1.83	2.27	4.83	2.93	0.09	6.32	5.39	3.79	3.72	40.14
1882	1.43	6.32	2.37	4.72	5.32	5.04	5.27	4.27	2.62	3.26	3.26	2.11	46.09
1883	1.34	4.90	1.51	2.29	4.06	6.59	3.52	0.19	0.31	4.91	2.67	1.51	33.80
1884	2.37	3.29	4.37	2.99	2.62	2.42	6.75	2.33	8.21	1.72	2.60	4.01	42.68
1885	2.91	0.66	0.38	5.20	2.75	6.67	2.67	5.02	7.51	2.10	1.63	2.30	39.80
1886	2.51	0.74	1.31	3.08	2.88	5.66	0.03	2.53	4.77	1.27	1.99	0.88	27.65
1887	1.38	2.86	1.45	3.30	4.60	2.06	0.73	0.39	3.69	0.73	1.82	4.02	27.04
Average	1.57	2.88	2.21	3.18	3.70	4.57	3.22	2.42	3.89	2.39	2.68	2.48	35.19

Miami, Saline County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	1.22	3.53	3.89	3.19	5.69	1.85	4.38	2.68	2.10	1.63	0.54	3.50	34.20
1879	0.60	0.43	0.73	2.90	2.09	11.11	5.64	2.84	3.87	2.55	2.54	2.25	37.55
1880	1.76	1.66	1.76	1.52	6.10	1.07	2.21	4.38	4.64	2.63	2.22	1.18	31.13
1881	0.36	4.52	2.63	2.48	*4.20	8.48	0.94	1.29	5.24	5.66	2.65	3.40	41.85
1882	0.92	2.83	2.95	4.60	4.50	4.20	3.91	3.36	3.83	3.54	*3.00	*1.50	39.14
1883	*1.70	*3.80	*1.30	1.52	6.29	11.45	6.88	0.59	*0.80	6.47	1.96	*1.00	43.76
1884	1.52	1.62	2.30	3.99	3.70	4.84	14.17	6.52	6.59	5.09	1.64	3.68	55.68
1885	2.76	1.28	0.45	7.25	2.68	6.36	3.90	6.43	5.39	4.88	1.93	2.06	45.37
1886	3.05	2.17	1.63	3.43	3.50	7.39	0.20	3.79	4.51	1.73	1.79	*0.70	33.87
1887	1.57	3.29	1.35	2.78	1.95	7.88	3.92	2.44	6.48	2.50	1.46	3.06	38.68
Average	1.55	2.51	1.90	3.37	4.07	6.46	4.62	3.43	4.34	3.67	1.97	2.23	40.12

* Approximated.

Mine La Motte, Madison County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1877.....	....	....	....	....	....	4.44	0.75	5.19	5.06	3.44	4.25	2.25	....
1878.....	3.81	1.94	3.25	7.63	5.06	3.88	3.50	3.69	3.81	2.69	1.25	3.50	44.01
1879.....	1.56	1.31	2.31	1.38	2.31	6.19	2.75	9.06	2.06	1.63	6.56	4.38	41.50
1880.....	5.00	4.69	4.56	3.31	5.25	4.69	5.69	3.50	4.44	2.19	4.00	1.94	49.26
1881.....	1.44	4.94	2.19	3.56	4.25	5.69	0.94	2.44	1.56	4.38	5.81	2.75	39.95
1882.....	3.19	7.00	3.06	1.81	6.75	3.00	5.75	4.25	2.75	3.56	5.50	1.88	48.50
1883.....	2.31	8.06	2.25	4.69	5.31	8.19	5.94	4.25	0.38	8.63	7.19	2.06	59.26
1884.....	1.38	5.38	2.75	2.75	6.38	4.38	6.44	1.19	2.88	1.69	1.94	6.13	43.29
1885.....	2.75	0.88	1.63	3.38	2.68	8.06	5.88	3.13	3.19	1.81	2.94	2.56	38.89
1886.....	2.38	2.38	3.00	4.56	4.25	6.06	2.31	1.81	6.13	1.25	5.13	2.56	41.82
1887.....	1.44	4.06	2.81	1.94	4.94	1.69	4.31	2.81	1.81	0.88	3.56	3.44	33.69
Means..	2.53	4.07	2.78	3.50	4.72	5.18	4.35	3.61	2.90	2.87	4.39	3.12	44.02

Pierce City, Lawrence County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	*2.20	*3.00	*3.00	*5.00	*6.00	*6.00	3.70	0.40	3.30	1.90	1.30	1.30	37.10
1879.....	1.50	5.90	0.60	2.70	4.80	4.40	3.10	2.20	1.00	1.60	6.00	2.80	36.60
1880.....	2.60	4.20	2.80	6.80	4.60	3.60	5.50	7.10	1.40	5.10	1.60	2.40	47.70
1881.....	1.30	5.10	3.10	1.80	6.70	5.10	2.00	2.60	5.40	8.10	3.70	1.70	46.60
1882.....	2.30	5.20	4.00	3.80	5.30	3.40	8.20	0.00	2.30	9.50	5.60	1.00	50.60
1883.....	1.00	7.65	1.90	2.70	4.40	6.00	9.30	4.80	0.20	8.90	2.80	2.30	51.95
1884.....	0.90	4.70	1.30	5.60	4.10	4.20	5.10	3.70	7.30	*2.00	2.90	10.10	51.90
1885.....	1.20	0.90	1.90	6.80	5.50	5.10	8.70	7.20	6.90	1.40	2.40	1.00	49.00
1886.....	2.10	1.80	3.30	2.50	2.20	7.40	8.40	3.10	4.30	2.50	1.80	*1.50	40.90
1887.....	*2.20	*3.70	3.65	2.70	3.30	*5.70	*2.70	*6.00	*1.70	5.10	3.80	4.10	44.65
Means..	1.73	4.21	2.56	4.04	4.69	5.09	5.67	3.71	3.38	4.61	3.19	2.82	45.70

* Approximated.

Pleasant Hill, Cass County, Mo.

Date.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878....	0.78	1.95	2.09	2.69	4.72	4.31	3.20	1.80	1.85	1.27	0.62	3.98	29.26
1879....	0.81	0.40	0.55	2.11	1.67	6.35	*6.00	0.20	1.31	*4.20	*4.30	*2.40	30.30
1880....	2.20	1.50	1.80	2.02	3.50	2.35	3.50	5.50	1.54	1.95	2.51	0.40	28.77
1881....	0.15	4.65	2.55	*1.50	*4.00	*5.00	*1.60	*3.00	*6.00	*6.00	*1.80	*2.20	38.45
1882....	1.00	2.85	2.50	2.98	4.83	3.82	1.31	0.95	1.85	4.26	2.67	1.15	39.17
1883....	1.35	3.85	1.80	2.02	6.05	8.90	7.05	3.73	2.00	8.13	*1.90	1.32	48.10
1884....	*1.60	*1.70	*2.30	*5.00	0.91	4.50	4.40	4.30	10.30	4.15	*1.80	1.92	42.88
1885....	1.30	*1.40	0.50	10.05	2.49	4.55	*5.00	2.00	4.80	2.20	1.00	1.25	36.54
1886....	1.95	0.94	1.24	2.16	6.65	2.40	0.00	1.05	2.40	1.50	2.46	1.20	23.95
1887....	1.15	3.65	1.35	3.70	2.15	6.55	2.46	3.00	*3.60	*2.00	*1.40	*3.00	34.01
Average	1.23	2.29	1.67	3.42	3.70	4.87	3.45	2.55	3.56	3.57	2.05	1.88	34.24

* Approximated.

Savannah, Andrew County, Mo.

Date.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878....	*1.20	*1.00	*2.80	*2.40	*4.50	*4.00	*6.20	*1.50	*3.20	*2.00	*0.70	*2.20	31.70
1879....	*1.00	*0.40	*0.40	*3.00	*2.30	*7.00	*6.60	*1.00	*3.00	*2.50	8.90	1.65	37.75
1880....	1.52	0.80	1.35	2.85	4.90	3.28	3.52	6.81	2.67	2.16	1.15	1.06	32.67
1881....	0.57	4.22	1.86	3.11	4.80	7.14	1.70	2.42	3.31	7.75	3.20	1.13	41.21
1882....	1.00	1.32	1.87	5.90	*3.60	*5.00	*1.10	*0.80	*0.70	*4.30	*1.70	*1.60	28.89
1883....	*1.50	*3.40	0.45	2.75	6.50	9.32	*2.00	*1.00	*1.70	*6.50	*1.00	*0.80	36.92
1884....	1.10	1.02	1.85	2.70	3.55	*5.00	4.90	*4.00	*4.20	3.95	1.50	2.20	35.97
1885....	*1.70	1.15	*0.40	4.30	2.55	3.90	4.55	0.75	3.45	5.35	1.00	0.90	30.00
1886....	2.12	0.40	2.22	2.10	1.80	2.60	0.30	2.22	3.10	3.95	0.90	0.45	22.16
1887....	0.85	3.25	1.50	*2.00	*3.00	*3.20	*1.60	*5.20	5.25	2.80	*1.00	1.60	31.25
Average	1.26	1.70	1.47	3.11	3.75	5.04	3.25	2.57	3.06	4.13	2.10	1.36	32.79

* Approximated.

Sedalia, Pettis County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yea.
1878	1.52	3.07	2.91	3.02	3.16	2.86	3.15	2.81	1.49	0.51	0.67	4.53	29.70
1879	1.47	0.65	0.43	4.33	0.97	8.48	4.19	0.60	3.77	2.01	2.75	1.32	30.97
1880	0.88	1.81	1.02	2.36	5.03	2.11	1.75	2.52	*2.00	1.72	1.46	0.62	23.28
1881	0.19	3.18	3.27	1.40	4.30	2.96	1.62	1.27	7.42	5.28	3.17	2.09	36.15
1882	1.44	4.95	2.01	2.26	4.68	4.15	5.46	1.62	1.81	4.99	2.56	1.06	36.99
1883	*1.40	4.44	2.55	1.85	5.66	7.63	7.83	0.90	*0.40	7.07	1.56	1.01	42.30
1884	3.53	*3.00	3.20	*3.30	*3.00	*4.30	6.93	2.22	10.54	2.81	2.24	4.77	49.84
1885	4.01	1.34	0.65	5.09	5.39	8.92	5.07	2.61	7.19	2.63	0.53	1.00	44.43
1886	1.00	1.12	1.65	4.37	6.51	8.41	0.62	1.42	4.38	2.40	2.81	0.53	35.22
1887	2.01	1.94	1.84	4.12	3.98	7.83	3.16	0.69	6.05	1.45	1.80	3.10	37.97
Average.	1.74	2.55	1.95	3.21	4.27	5.76	3.98	1.67	4.50	3.09	1.96	2.00	36.68

* Approximated.

Shelbina, Selby County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	*1.10	*3.90	*3.80	*2.10	*6.10	*2.00	*2.50	*3.30	*2.50	*2.00	*1.30	*1.50	32.10
1879	*0.70	*0.70	*1.00	*1.60	*1.20	*5.00	*3.50	*3.00	*2.50	*0.50	3.60	1.45	24.75
1880	1.90	1.75	1.45	0.81	5.00	1.82	3.56	2.40	1.20	2.40	2.11	0.76	25.16
1881	0.03	3.77	3.45	2.30	2.50	8.41	1.60	0.02	4.83	8.40	2.60	1.00	38.91
1882	1.20	2.21	3.11	5.00	4.00	7.20	3.00	0.50	2.60	4.96	2.90	2.40	39.08
1883	1.80	4.30	1.91	0.82	4.60	6.30	7.15	3.70	0.20	9.90	2.10	1.20	43.98
1884	0.70	2.50	2.40	1.10	3.40	4.00	5.80	4.70	6.30	2.10	0.18	4.20	37.38
1885	2.40	1.20	0.23	4.20	3.50	8.61	4.80	2.80	6.40	3.00	1.30	1.00	39.44
1886	2.90	1.21	2.90	*2.00	2.30	3.40	0.01	4.70	7.50	2.40	1.30	1.30	31.92
1887	2.20	2.57	1.00	2.20	3.70	1.43	4.20	1.51	5.40	1.50	1.30	3.30	30.31
Average.	1.49	2.41	2.13	2.21	3.63	4.82	3.61	2.66	3.94	3.72	1.87	1.81	34.30

* Approximated.

St. Charles, St. Charles County, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	*Nov.	Dec.	Year.
1878	1.85	1.58	3.45	4.45	4.94	1.51	0.70	1.41	3.35	1.90	1.10	2.87	29.11
1879	1.78	1.24	2.34	2.85	0.81	2.90	4.13	4.55	1.24	3.10	4.02	2.90	30.86
1880	1.37	2.65	1.95	2.63	3.20	4.15	5.40	1.60	1.12	2.10	3.10	2.40	31.67
1881	0.25	4.70	2.20	2.00	5.90	3.22	0.90	0.60	4.25	6.40	6.60	0.80	37.82
1882	2.15	8.01	2.55	2.50	4.60	4.80	3.30	2.40	1.20	3.20	3.20	1.25	39.16
1883	0.90	7.10	2.20	2.00	2.60	5.60	3.10	1.90	0.00	5.41	3.95	1.46	36.22
1884	1.45	4.80	4.25	4.10	2.45	6.55	4.70	4.40	4.25	2.00	1.65	3.70	44.30
1885	2.75	0.80	0.50	4.60	2.10	7.90	3.30	5.70	4.50	2.85	1.80	2.00	38.80
1886	3.50	1.50	2.80	1.45	4.05	5.50	0.50	2.60	5.10	0.70	3.80	1.00	32.50
1887	0.95	4.15	2.80	3.94	5.75	1.35	2.15	2.40	2.50	1.00	4.00	2.60	33.59
Average.	1.69	3.65	2.50	3.05	3.64	4.35	2.82	2.76	2.75	2.77	3.32	2.10	35.40

Washington University, St. Louis, Mo.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878	2.80	1.71	2.94	6.31	4.70	2.44	2.87	5.06	3.93	3.32	1.02	3.56	40.66
1879	1.86	1.66	1.70	2.69	0.90	3.86	2.16	2.12	1.45	0.57	4.22	2.77	25.96
1880	3.94	3.13	3.10	3.44	3.21	2.50	5.37	2.00	3.45	2.08	3.24	1.64	37.10
1881	0.39	4.74	2.47	3.01	4.00	3.23	2.35	0.27	2.80	7.60	6.32	1.50	38.68
1882	3.68	7.21	3.39	4.30	4.36	4.78	3.56	2.53	1.46	2.33	3.16	1.75	42.51
1883	1.03	6.27	2.21	2.62	2.61	4.73	4.11	2.24	0.00	6.00	2.18	1.42	35.42
1884	2.08	3.88	3.63	3.92	2.49	4.01	2.94	1.39	6.06	1.86	2.19	6.63	41.08
1885	3.56	1.00	0.49	4.28	2.50	6.30	1.28	2.74	8.62	7.02	1.80	2.01	41.60
1886	3.51	1.63	3.30	2.50	7.93	7.26	0.24	2.60	9.57	0.95	3.87	3.04	46.40
1887	0.70	3.78	3.87	5.50	5.46	2.29	2.70	1.01	2.60	0.60	4.79	3.24	36.54
Average.	2.36	3.50	2.71	3.86	3.82	4.14	2.76	2.20	3.99	3.23	3.28	2.76	38.60

*Stations having a Record of less than Ten Years.***Station near Allenton, St. Louis Co., Mo.**

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1864.....	.....	.....	.....	.....	.....	.....	0.14	1.66	3.37	2.13	3.90	1.63	.....
1865.....	0.65	4.27	8.87	3.89	4.63	4.57	9.26	.....	.....	.....	.....	.....	.....
1866.....	.....	.....	2.97	3.68	3.04	3.32	4.93	3.53	8.90	2.93	1.48	2.78	.....
1867.....	2.66	3.48	2.76	0.89	7.86	5.14	2.95	2.25	0.52	1.54	2.24	2.59	34.88
1868.....	1.69	0.82	8.87	6.05	5.71	1.67	2.30	5.54	7.19	1.90	2.01	3.22	46.97
1869.....	1.94	2.45	4.21	6.08	3.71	8.14	1.82	2.75	1.60	2.74	5.66	2.70	43.80
1870.....	2.31	0.59	4.95	2.60	2.57	4.88	3.67	5.99	0.99	4.13	2.16	2.85	37.69
1871.....	4.26	4.21	1.93	1.00	4.35	1.19	4.48	.....	.....	.....	.....	.....	.....

Ashley, Pike County, Mo.

1878.....	.....	.....	.....	.....	.....	.....	.....	.....	1.33	2.15	1.21	3.01	.....
1879.....	1.41	0.73	2.18	4.24	3.69	3.16	3.99	1.76	2.55	2.74	4.47	2.26	33.18
1880.....	1.51	2.35	1.87	2.05	7.00	4.61	.....	.....	*2.01	1.35	2.09	1.79	.....
1881.....	0.31	3.62	3.67	1.73	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Twenty-three days.

Big Creek,* Lincoln County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	1.70	3.10	3.70	4.66	4.28	1.05	1.12	5.86	1.71	0.86	0.60	3.27	31.91
1879.....	2.52	0.65	2.73	1.90	1.22	2.44	2.34	0.24	1.00	0.70	4.51	2.20	22.45
1880.....	1.13	1.75	0.92	2.02	4.90	2.90	3.64	3.76	2.23	1.32	1.67	1.56	27.80
1881.....	0.22	2.57	3.70	1.80	2.96	2.85	2.53	0.01	9.01	4.93	5.27	0.85	36.70
1882.....	2.65	6.46	2.16	3.45	4.65	4.18	4.47	2.10	2.95	3.20	1.50	2.05	39.82
1883.....	1.25	5.90	1.70	.....	4.05	5.99	1.85						

* Near Troy, Mo.

Bolivar, Polk County, Mo.

1868.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.65	.....
1869.....	4.50	0.95	4.90	3.65	3.40	3.70	3.10	2.81	1.20	0.12	6.50	4.30	39.13
1878.....	1.20	1.86	2.00	5.30	8.00	4.90	0.50	2.70	1.10	1.90	1.70	2.40	33.56
1879.....	0.50	1.40	1.30	2.50	3.20	5.10	2.20	2.50	0.50	3.60	3.20	3.60	29.60
1880.....	0.80	1.90	1.30	4.30	4.70	2.20	6.10	3.51	2.00	2.70	1.30	1.20	32.01
1881.....	0.40	4.30	1.90	2.10	4.40	6.10	1.60	2.20	4.20	7.40	4.60	1.30	40.50
1882.....	1.90	5.00	2.80	1.40	5.70	2.20	2.00	2.80	5.90	3.20	3.80	2.30	39.00
1883.....	0.60	5.00	2.00	1.20	4.03	6.40	5.50	*1.50	0.30	6.70	1.80	2.30	37.33
1884.....	0.70	2.50	2.50										

* Approximated.

Carrollton, Carroll County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1879.....	.....	.....	.....	.....	.....	.....	.....	1.10	4.30	5.45	3.75	6.70	.....
1880.....	2.50	4.00	3.20	1.61	5.95	1.45	3.50	6.43	5.15	3.25	2.09	0.49	39.62
1881.....	0.00	4.26	4.55	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Cave Springs, Greene County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1871.....	4.65	2.74	3.19	3.13	.....	.....	.....	3.20	0.10	7.00	4.00	1.30	.....
1872.....	1.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1873.....	.....	.....	.....	.....	.....	.....	1.90	1.50	6.50	2.60	1.10	4.80	.....
1874.....	2.82	2.20	2.90	6.60	3.10	1.70	1.50	2.70	4.10	1.20	7.00	1.30	37.12
1875.....	0.80	3.30	3.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Chillicothe, Livingston County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	0.57	2.69	2.39	2.48	.....	2.32	7.57	3.50	.....	.....	.....	.....	.....
1880.....	*2.00	*1.00	*3.00	*2.00	1.70	1.30	2.14	5.02	2.50	3.35	2.01	1.42	27.44
1881.....	2.34	5.96	2.50	4.49	5.94	9.17	1.20	*1.50	6.20	*6.50	2.60	1.55	49.95
1882.....	0.50	2.05	1.30	.....	.....	8.70	.....	.....	.....	.....	.....	.....	.....

* Approximate.

Clinton, Henry County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	1.50	1.95	2.15	6.64	7.20	3.71	3.90	2.10	*1.50	*0.50	*1.20	*3.60	35.95
1879.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.50	1.20	.....
1880.....	0.30	0.70	0.50	1.10	5.10	2.80	1.77	*4.00	*1.20	1.60	*1.00	0.40	20.47
1881.....	0.00	3.00	1.80	*1.00	*4.50	3.50	1.70	2.20	*6.00	*7.00	3.40	1.49	35.59
1882.....	1.79	4.67	2.15	2.58	6.69	2.85	4.73	2.83	0.86	7.63	2.50	*1.20	40.48
1883.....	1.60	4.54	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Approximated.

Conception, Nodaway County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1883.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.21	0.43	.....
1884.....	0.75	0.43	2.41	2.44	3.84	3.02	6.12	.....	4.07	2.92	0.94	1.46	.....
1885.....	.....	.....	0.10	4.93	1.96	9.25	1.75	1.85	2.47	4.83	0.60	1.30	.....
1886.....	2.51	0.75	.....	2.76	4.73	2.12	0.68	1.57	5.05	5.34	1.39	0.70	.....
1887.....	5.06	2.79	3.54	1.50	4.00	4.69	1.27	3.87	5.18	2.25	0.67	0.73	35.55

Cuba, Crawford County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	*2.50	*2.00	*3.75	*6.50	*6.00	2.04	4.66	8.17	3.50	*2.00	1.43	2.29	44.84
1879.....	1.19	1.12	*1.50	*2.50	1.78	4.60	5.69	3.04	4.43	4.04	4.72	2.67	37.28
1880.....	2.74	3.02	*2.75	*5.50	3.67	3.81	3.20	0.50	0.68	2.58	2.88	3.00	34.33
1881.....	0.76	4.23	*1.25	*2.00	*5.00	7.10	0.93	0.05	*5.00	*5.25	*5.50	*0.75	37.82

* Approximated.

East Prairie, Mississippi County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868.....	3.37	1.00	5.27	6.15	0.95	1.31	3.65	4.90	4.30	2.00	1.75	5.60	40.25
1869.....	1.25	2.00	2.45	4.00	3.92	2.25	10.70	1.50	0.15	1.05	4.20	1.83	35.30
1870.....	2.45	3.30	2.71	2.90	1.90	2.41	5.90	4.35	0.95	1.35	2.40	2.25	32.87
1878.....	2.61	1.80	2.90	2.97	5.20	4.15	2.47	2.22	3.05	2.12	3.60	3.45	36.54
1879.....	3.01	2.00	2.71	3.40							5.00		

Edina, Knox County, Mo.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1859.....	.....	.....	.....	.....	3.87	2.50	1.50	3.75	3.75	0.25	2.50	0.60	.....
1860.....	0.80	1.40	0.25	0.12	0.62	5.50	1.37	3.25	2.88	0.75	0.06	3.88	20.88
1861.....	1.35	0.80	3.80	6.37	1.87	4.06	1.66	0.66	3.66	1.56	1.06	1.23	28.08
1862.....	3.75	0.40	1.23	4.50	2.04	5.66	1.68	3.00	4.25	2.37	1.12	4.45	34.45
1863.....	1.80	2.53	2.46	0.32	4.12	1.33	1.35	3.24	2.00	2.35	0.75	2.47	24.72
1864.....	1.18	0.50	0.79	5.78	1.33	2.06	3.00	1.00	3.75	1.88	2.45	2.70	26.42
1865.....	0.10	2.45	2.64	5.57	0.12	5.84	10.20	1.64	6.65	4.25	0.00	1.00	40.46
1866.....	3.18	1.34	4.95	4.00	1.56	4.12	5.75	0.45	10.12	1.12	1.50	2.85	40.94

Fayette, Howard County, Mo.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1886.....	.....	0.90	2.35	3.57	3.12	5.40	0.76	3.06	6.11	1.99	1.85	0.79	.....
1887.....	1.10	2.92	1.21	3.62	4.55	3.30	1.37	0.49	3.73	1.57	1.76	3.42	29.04

Forsythe, Taney County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.80	0.60	3.00	.....
1879.....	1.70	0.70	0.99	1.04	2.67	3.20	1.00	1.00	0.30	1.60	3.10	2.20	19.50
1880.....	0.40	0.60	4.10	*5.00	1.20	3.80	*4.50	5.00	*1.50	4.80	2.40	0.50	33.80
1881.....	1.89	4.60	1.10	1.90	2.90	*5.00	*1.00	*2.50	1.80	1.80	1.30	2.40	28.19
1882.....	3.40	.....	.....	.....	.....	3.21	5.65	1.02					

* Approximated.

Gayoso, Pemiscot County, Mo.

1878.....	2.60	3.00	3.10	4.00	3.80	5.20	5.60	1.40	3.60	2.30	3.80	2.90	41.30
1879.....	4.30	2.80	2.60	3.50	1.00	3.50	4.70	7.00	1.90	2.50	4.70	7.50	46.00
1880.....	6.50	7.70	3.60	5.00	2.60	2.80	4.00	2.10	4.80	3.50	3.80	3.40	49.80
1881.....	4.10	6.00	2.40	4.00	6.20	8.90	1.30	*2.50	*2.40	*2.50	*5.00	*2.50	47.80

Grant City, Worth County, Mo.

1878.....	0.00	0.06	1.16	1.14	2.05	3.70	5.90	2.70	2.01	2.10	*0.70	*1.00	22.52
1879.....	0.50	0.20	0.40	2.30	2.05	.....	.....	1.80					
1881.....	.....	.....	.....	4.30									

* Approximated.

Hamilton, Caldwell County, Mo.

1878.....	0.60	2.80	2.48	1.27	2.59	1.80	2.94	2.96	2.87	0.66	0.53	2.36	23.86
1879.....	0.75	0.38	0.30	1.56	1.61	7.97	4.02	2.43	2.48	3.13	4.50	1.40	30.53
1880.....	1.80	0.75	2.65	2.25	3.37	1.84	2.05	4.77	2.70	3.00	2.00	0.70	27.88

Hannibal, Marlon Co., Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1854.....	0.31	1.91	3.81	3.36	4.50	4.50	1.25	1.84	1.90	2.91	0.50	0.89	27.68
1855.....	.....	0.56	2.00	0.94	7.00	.....	.....	.....	.....	.....	.....	.....	.....
1878.....	.....	.....	.....	.....	.....	.....	.....	.....	1.23	2.37	0.62	2.30	.....
1879.....	0.61	0.84	.....	1.60	2.40	2.20	3.30	3.00	1.60	0.30	2.70	0.30	.....
1880.....	1.40	1.80	1.00	1.20	4.70	2.10	1.00	1.20	0.70	1.20	1.10	0.95	18.35
1881.....	0.00	2.21	1.30	0.40	2.40	8.50	2.30	0.10	3.90	10.70	3.20	2.25	37.26
1882.....	*1.50	3.60	3.10	4.30	5.90	6.80	2.90	2.40	1.20	3.90	2.30	*2.00	39.90
1883.....	*1.50	3.20	1.80	1.40	4.50	9.70	5.40	1.60	1.10	8.00	4.70	1.30	44.20
1884.....	*0.80	1.71	4.30	1.90	3.40	1.47	2.46	3.23	*6.00	3.10	*1.60	*3.50	33.47
1885.....	3.60	1.00	*0.10	4.70	4.50	4.80	*2.00	2.50	4.45	3.60	0.80	1.00	33.05
1886.....	.....	0.70	.....	2.10	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Approximated.

Harlem, Clay County, Mo.

1878.....	1.20	2.20	3.50	2.55	2.60	0.79	1.80	1.72	2.70	1.00	0.50	4.50	25.06
1879.....	0.60	0.45	0.80	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Harrisonville, Cass County, Mo.

1863.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.31	.....	.....	.....
1864.....	.....	.....	.....	5.61	2.20	2.37	3.50	1.91	3.31	2.81	3.81	2.25	.....
1865.....	0.45	3.40	3.44	7.41	4.64	12.16	10.66	6.45	8.09	0.74	0.04	1.02	58.50
1866.....	1.25	1.67	2.20	7.92	5.52	4.38	7.87	4.00	9.68	7.78	2.89	3.21	58.37
1867.....	1.31	6.56	4.90	4.91	10.64	2.58	2.40	2.80	5.23	1.74	0.86	0.99	44.92

(Continued.)

Harrisonville (continued).

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868.....	0.50	0.48	.....	2.51	4.23	3.73	1.54	8.96	6.63	2.53	6.20	4.86	.....
1869.....	4.31	1.20	1.34	4.48	3.23	8.42	2.31	3.85	3.55	0.16	1.60	1.62	36.07
1870.....	0.50	.....	0.97	0.63	2.76	2.00	2.09	7.43	4.11	.....	.....	.....	.....
1878.....	.....	.....	.....	.....	.....	3.93	2.58	3.00	1.51	0.42	0.69	3.95	.....
1879.....	0.50	0.60	0.31	2.10	3.07	4.91	4.85	0.86	2.88	4.37	4.27	2.14	30.86
1880.....	1.15	1.25	0.87	2.05	2.60	2.18	3.52	5.27	1.26	2.09	1.57	0.44	24.25
1881.....	0.42	5.21	2.05	1.20	4.55	4.22	1.85	3.45	5.80	6.85	1.70	2.05	39.35
1882.....	1.19	1.42	3.50	2.92	5.02	3.78	2.09	0.95	2.01	3.51	1.99	1.24	29.62
1883.....	2.01	5.24	0.85	0.37	7.25	7.53	2.85	2.23	1.10	4.40	1.92	1.20	36.95
1884.....	1.60	1.78	2.30	5.53	0.75	2.45	2.42	2.30	9.18	4.43	1.87	3.74	38.35
1885.....	2.85	.....	0.97	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1887.....	.....	.....	.....	.....	.....	.....	.....	5.00	3.10	1.69	1.43	2.96	.....

Hematite, Jefferson County, Mo.

1868.....	.....	.....	.....	7.40	7.70	4.80	2.65	5.90	7.05	1.80	2.05	3.45	.....
1869.....	1.40	2.10	5.90	2.80	3.95	5.45	4.55	7.10	2.40	2.40	5.20	2.25	45.50
1870.....	2.60	0.20	4.05	2.55	1.25	1.25	4.41	4.56	1.37	4.45	2.19	3.62	32.50
1871.....	4.31	3.63	2.01	0.77	4.48	1.67	4.76	1.21	0.48	2.62	1.68	1.20	28.82
1872.....	1.59	2.56	2.78	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Hermitage, Hickory County, Mo.

1867.....	.....	.....	.....	.....	.....	.....	.....	.....	0.13	2.32	1.63	0.69	.....
1868.....	0.63	0.15	.....	4.93	1.29	1.47	4.09	5.54	6.12	1.47	3.35	3.42	.....
1869.....	2.68	1.96	2.91	1.88	6.22	6.25	5.25	1.14	1.72	2.32	3.25	2.40	37.98

Hopkins, Nodaway County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	0.05	0.72	2.24	1.92	6.09	6.97	6.34	1.24	*2.00	*3.00	*0.70	*1.00	32.27

* Approximated.

Houstonia, Pettis County, Mo.

1885.....	2.56	1.11	0.86	5.27	3.02	5.81	4.63	2.81	6.00	3.25	1.40	1.04	37.76
1886.....	1.70	0.88	1.46	6.42	5.15	4.24	0.06	1.60	4.09	1.34	1.46	0.54	28.94
1887.....	1.48	3.13	1.07	3.69	4.19	10.07	1.72	1.97	*6.00	*1.50	*1.80	*3.00	39.62

* Approximated.

Jackson, Cape Girardeau County, Mo.

1878.....	3.85	1.51	2.73	6.50	4.99	2.84	3.55	*2.00	1.75	3.52	2.30	3.71	.....
1879.....	1.94												

* Approximated.

Jefferson City, Cole County, Mo.

1875.....	.....	.....	.....	4.14	3.23	4.71	6.28	0.80	0.00	0.00	0.00	1.16	.....
1876.....	*0.53	.....	*0.62	*0.82	2.25	7.19	9.31	5.15	1.53	2.06	1.25	.....	.....
1877.....	.....	.....	.....	*3.73	5.48	.....	.....	.....	.....	.....	.....	.....	.....
1878.....	.....	.....	.....	.....	.....	.....	*0.38	*0.95	.....	.....	.....	.....	.....
1879.....	.....	.....	.....	.....	1.60	5.20	1.80	0.60	3.00	1.60	3.00	.....	.....
1880.....	.....	2.20	1.40	0.60	.....	1.50	0.80	2.20	2.20	0.20	1.40	1.20	.....
1881.....	.....	2.00	2.40	1.60	3.00	0.80	1.60	0.20	3.60	3.80	3.00	2.00	.....
1882.....	2.20	5.80	2.80	3.00	3.20	1.20	5.20	1.60	2.60	0.00	5.80	1.20	34.60
1883.....	1.20	2.80	2.80	1.80	5.48	3.37	0.33	0.07	0.91	3.60	0.60	0.85	23.81
1884.....	.....	2.40	2.80	1.40	2.00	2.80	4.40	5.60	7.40	1.60	2.40	6.40	.....
1885.....	2.80	0.00											

* Incomplete.

Macon City, Macon Co., Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	1.00	3.50	3.81	1.10	7.10	1.52	2.88	1.62	3.28	1.73	1.45	1.41	30.40
1879.....	0.74	0.25	0.84	1.94	0.87	5.52	3.48	3.18	3.41	0.33	2.84	1.95	25.40
1880.....	2.53	0.94	1.79	*1.50	4.79	3.78	1.97	3.70	2.55	1.71	1.76	0.50	27.52
1881.....	0.00	2.23	2.21	2.59	6.47	10.00	2.25	0.25	5.35	8.88	2.25	1.91	44.39
1882.....	0.18	1.85	4.09	4.62	5.62	7.64	4.49	3.94	2.38	5.38	2.84	1.97	45.00
1883.....	2.20	5.23	1.98	0.58	5.95	9.56	6.68	2.78	0.35	8.18	1.87	1.13	46.49
1884.....	1.00	1.85	1.75	1.30	2.57	3.50							

* Approximated.

Mound City, Holt Co., Mo.

1886.....	*2.00	*0.80	*2.80	*3.30	1.10	1.51	0.32	1.01	2.55	3.55	1.64	0.53	21.11
1887.....	0.70	1.64	.....	.....	5.21	3.14	.....	.....	.....	3.40	3.25		

* Approximated.

Mt. Vernon, Lawrence County, Mo.

1871.....	.....	.....	.....	.....	.....	.....	5.05	4.31	0.35	8.65	4.17	0.72	.....
1872.....	1.01	.....	.....	.....	13.70	1.45	8.35	2.55	3.60	1.35	0.65	1.66	.....
1873.....	5.35	3.75	2.00	4.97	3.35	3.00	1.70	2.60	4.75	1.55	1.35	3.85	38.22
1874.....	3.20	2.50	3.45	4.50	2.60	1.75	1.45	.....	.....	.....	.....	.....	.....
1875.....	.....	.....	.....	6.45	4.15	8.00	14.85	1.65	0.80	1.70	.....	.....	.....

Near Protem, Taney County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1881.....	.....	.....	.....	.....	.....	.....	.....	.....	4.09	6.21	3.91	2.82	.....
1882.....	3.31	8.98	4.00	6.61	10.56	7.14	8.41	6.42	4.70	7.22	3.52	2.93	73.80
1883.....	2.57	8.19	3.04	3.81	8.16	6.24	11.60	4.79	1.52	18.11	5.77	4.52	78.32
1884.....	2.05	10.93	3.95	3.87	5.93	3.57	5.04	4.78	5.14	0.94	4.71	11.37	62.28
1885.....	2.65	1.47	3.60	5.38	3.73	3.69	8.31	2.37	3.64	1.22	2.50	2.30	40.86
1886.....	2.45	2.61	4.87	5.44	2.04	5.42	5.91	3.91	8.44	0.10	3.49	1.51	46.19
1887.....	1.33	4.08	2.84	3.20	8.57	6.07	1.82	8.28	4.69	1.50	3.64	3.69	49.71

Station near Richland, Pulaski County, Mo.

1872.....	.....	.....	.....	.....	.....	.....	6.45	2.65	3.50	0.80	0.60	1.75	.....
1873.....	4.60	2.00	2.20	4.40	3.19	4.21	1.55	1.85	4.65	3.35	1.15	8.00	41.15
1874.....	1.90	3.75	2.70	3.00	.....	3.50	.....	.....	.....	.....	.....	.....	.....

Salem, Dent County, Mo.

1880.....	*3.00	*4.00	3.01	4.74	5.76	*4.50	*4.00	*0.70	2.59	2.94	2.29	1.68	39.21
1881.....	0.45	2.05	1.43	1.80	1.92	5.78	*1.00	2.00	2.05	5.15	3.85	1.50	28.98
1882.....	1.59	3.74	2.41	1.84	7.04	.....	.....	.....	.....	.....	.....	.....	.....

* Approximated.

Steelville, Crawford County, Mo.

1884.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.53	2.87	5.45	.....
1885.....	2.20	1.20	0.88	2.53	2.98	9.55	3.25	1.45	4.73	3.05	0.55	0.95	32.32
1886.....	2.10	1.63	1.72	2.30	6.20	6.20	0.20	0.95	6.15	0.60	3.52	2.30	33.87
1887.....	1.40	3.30	2.07	3.88	4.85	1.25	3.10	2.70	2.55	2.15	3.50	2.49	33.24

Waterworks, St. Louis, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1879.....	1.30	1.20	1.20	2.60	0.35	4.00	1.65	2.00	0.92	1.40	4.25	2.75	23.62
1880.....	2.90	2.50	2.05	3.19	2.60	2.71	4.92	1.50	2.50	2.25	2.91	1.44	31.47
1881.....	0.44	4.51	1.94	2.61	4.67	3.86	2.20	0.32	3.74	7.06	6.32	1.67	39.34
1882.....	2.34	6.99	3.57	3.47	4.22	4.57	1.10	2.07	1.38	3.21	2.77	1.49	37.18
1883.....	1.10	6.04	2.01	3.87	2.98	6.18	4.37	3.95	0.00	6.07	3.57	1.58	41.72
1884.....	0.70	3.74	3.44	3.30	2.85	3.49	3.11	1.98	4.28	2.00	2.02	5.21	36.12
1885.....	2.32	0.44	0.35	4.50	2.71	6.28	2.06	4.19	7.02	5.52	1.75	2.22	39.36
1886.....	2.60	1.40	3.00	4.62	7.32	6.56	0.58	2.51	8.20	0.54	3.28	2.68	41.29
1887.....	1.93	3.30	3.26	4.02	4.92	1.90	1.70	1.13	2.10	0.70	3.62	1.90	30.48

Tower Grove, St. Louis County, Mo.

1861.....	1.31	1.13	6.00	2.91	3.57	3.78	1.93	4.60	4.83	2.22	1.52	1.26	35.06
1862.....	3.03	0.51	3.07	4.99	2.57	3.27	4.53	0.63	6.03	2.33	3.47	5.71	40.14
1863.....	.....	3.58	2.19	.....	2.45	2.62	.....	.....	.....	.....	.....	.....	.....

Troy, Lincoln County, Mo.

1878.....	2.30	2.50	2.82	5.83	3.80	1.90	1.00	3.50	1.75	*0.90	*0.70	3.10	30.10
1883.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.50	2.50	.....
1887.....	*1.00	*3.00	2.70	6.20	3.80	2.30	3.80	1.50	2.75	0.50	1.20	2.00	30.75

* Approximated.

Unionville, Putnam County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1878.....	0.00	0.80	2.94	1.75	3.70	3.15	*2.70	*3.30	2.00	1.60	1.15	1.40	24.49
1879.....	0.90	0.70	0.60	2.15	5.15	*7.50	*3.00	*2.30	5.50	1.70	*6.80	*1.30	37.60
1880.....	.....	.....	2.70	.....	.....	.....	.....	.....	.....	.....	.....	2.78	.....
1881.....	0.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Approximated.

Warrensburg, Johnson County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1868.....	.....	.....	.....	.....	.....	.....	1.75	6.26	2.24	2.05	5.03	2.25	.....
1869.....	3.52	0.50	2.22	2.59	4.31	7.67	3.01	4.35	.....	.....	.....	.....	.....
1874.....	.....	.....	.....	.....	.....	.....	3.50	1.40	2.85	0.40	2.45	1.60	.....
1875.....	.....	4.77	4.20	2.15	4.50	.....	.....	.....	.....	.....	.....	.....	.....
1878.....	1.98	3.19	2.10	3.24	4.20	3.17	2.80	2.33	2.13	0.58	1.10	3.88	30.70
1879.....	1.13	0.13	0.65	2.67	1.23	6.18	7.35	0.34	2.64	3.97	1.97	2.47	30.73
1880.....	1.07	1.21	1.23	2.04	2.34	4.28	*2.00	*4.00	*2.00	*2.00	1.74	0.62	24.53
1881.....	0.11	*4.50	2.59	1.41	3.49	5.35	1.43	*2.00	*6.30	5.92	3.42	2.14	38.66

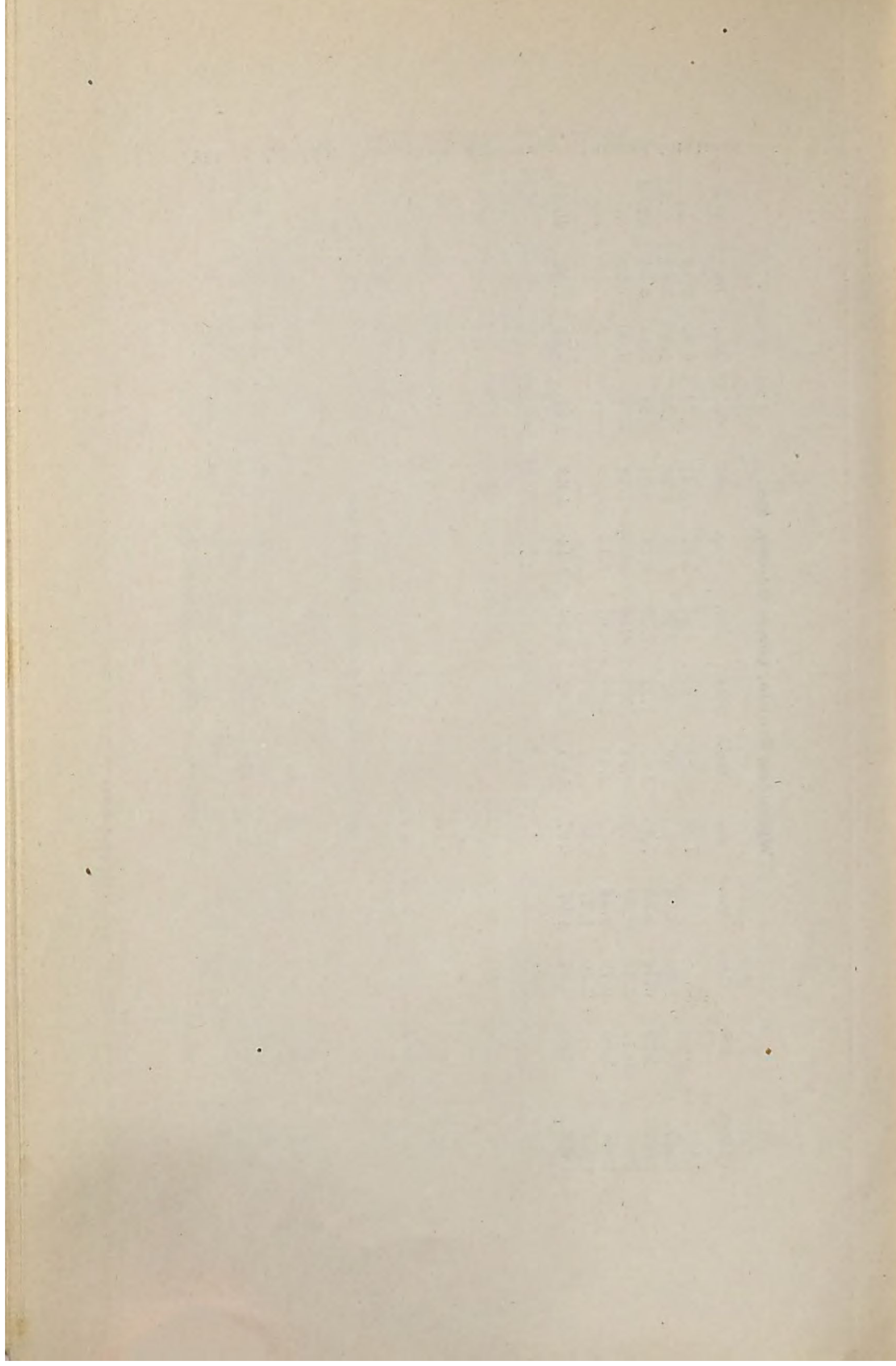
* Approximated.

Wet Glaze, Camden County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1872.....	1.60	0.94	2.00	4.00	6.60	2.30	5.70	4.60	2.90	0.50	.....	9.30	.....
1873.....	4.10	2.10	1.40	4.65	2.70	3.50	0.90	1.40	3.50	2.70	0.50	8.60	36.05
1874.....	2.00	2.80	2.80	4.60	2.30	2.50	3.50	5.00	4.30	3.70	4.70	1.30	.....
1875.....	.....	2.76	2.80	4.50	5.70	5.20	17.80	1.70	.....	1.00	.....	2.70	.....
1876.....	.....	4.60	.....	.....	4.30	5.80	12.00	.....	3.20	0.80	0.80	.....	.....
1877.....	1.00	0.10	2.30	4.20	3.60	.....	3.20	2.90	1.90	3.90	3.60	.....	.....

Wyaconda Prairie, Lewis County, Mo.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1862.....	.....	.....	.....	7.80	1.61	8.01	4.57	3.27	10.31	1.72	2.80	6.65	.....
1863.....	.....	2.95	3.62	.....	2.36	0.65	0.77	3.34	2.86	7.56	1.26	3.64	...
1864.....	1.32	0.46	1.83	7.43	2.07	1.12	7.48	3.24	5.24	5.31	3.28	4.06	42.84
1865.....	0.14	3.16	8.89	.....	0.71	5.01	8.54	2.06	7.42	3.96	0.00	1.22	.....
1866.....	3.45	0.79	2.13	.....	2.13	1.87	5.67	2.13	.....	.....	.....	.....	.....
1867.....	.....	3.40	1.37	2.50	.....	.....	.....	.....	.....	.....	.....	.....	.....
1868.....	0.60	0.61	4.07	7.97	6.05	2.32	2.56	2.46	4.64	2.37	5.01	2.33	40.99



MISSOURI RAINFALL.

STATION.	COUNTY.	State	Number.	JANUARY.				FEBRUARY.				MARCH.				APRIL.				MAY.				JUNE.				JULY.															
				Average.	Max.		Min.	Average.	Max.		Min.	Average.	Max.		Min.	Average.	Max.		Min.	Average.	Max.		Min.	Average.	Max.		Min.	Average.	Max.		Min.												
					Amt.	Year.			Amt.	Year.			Amt.	Year.			Amt.	Year.			Amt.	Year.			Amt.	Year.			Amt.	Year.		Amt.	Year.	Amt.	Year.	Amt.	Year.	Amt.	Year.	Amt.	Year.	Amt.	Year.
Boonville	Cooper	Mo.	1	1.51	4.00	1886	0.19	1881	3.26	6.04	1882	0.95	1879	2.25	5.11	1878	0.58	1879	3.41	6.26	1882	1.45	1883	5.19	7.92	1878	1.94	1879	6.57	10.84	1879	3.57	1878	3.69	6.83	1884	1.05	1881,'86					
Cairo .....	.....	Ills.	2	3.48	6.35	1882	2.15	1887	4.68	10.14	1882	1.48	1885	2.84	4.52	1880	1.08	1885	3.90	6.64	1886	1.43	1885	4.05	10.22	1882	1.37	1887	4.23	8.70	1879	1.81	1881	3.25	7.95	1883	0.18	1881					
Carthage	Jasper	Mo.	3	1.55	2.30	1885,'86	0.70	1887	2.92	5.12	1882	1.15	1885	1.90	3.75	1882	0.87	1883	3.38	7.54	1885	1.47	1883	4.13	6.47	1878	1.12	1886	4.81	7.23	1887	*2.50	1880	5.21	12.18	1883	1.50	1881					
Centreville	Reynolds	Mo.	4	2.12	3.57	1880	1.00	1881	4.04	6.95	1883	0.85	1885	2.91	6.11	1880	0.92	1879	2.95	6.57	1887	1.18	1882	4.11	8.06	1882	1.06	1884	5.37	10.73	1885	2.20	1878	4.64	7.95	1878	0.05	1886					
Chamois	Osage	Mo.	5	1.64	3.03	1886	0.09	1881	3.36	8.98	1882	0.74	1886	2.19	4.34	1884	0.51	1885	3.47	*6.30	1878	1.29	1883	4.07	7.33	1882	1.85	1879	4.58	7.94	1885	2.12	1880	2.71	5.93	1885	0.24	1881					
Glasgow, Morrison Observatory..	Howard	Mo.	6	1.12	2.16	1886	0.00	1881	2.20	4.51	1881	0.12	1879	1.88	4.38	1878	0.00	1885	2.83	6.48	1885	0.99	1880	3.57	5.77	1883	1.57	1879	4.99	8.04	1883	1.06	1880	3.51	12.16	1884	0.40	1886					
Glasgow	Howard	Mo.	7	1.35	2.16	1886	0.01	1881	2.60	5.45	1881	0.47	1879	2.02	4.35	1878	0.34	1885	2.64	5.31	1885	1.07	1880	3.53	6.00	1880	1.69	1879,'86	5.50	11.00	1883	0.96	1878	3.81	10.95	1884	0.40	1886					
Greenfield	Dade	Mo.	8	1.04	1.70	1881	0.30	1883	2.06	5.55	1882	0.60	1885	1.49	2.70	1882	0.50	1885	3.08	6.50	1884	0.65	1881	4.22	7.00	1878	2.50	1884	4.34	*6.50	1883	1.85	1880	4.62	9.00	1883	1.70	1881					
Hermann	Gasconade..	Mo.	9	1.80	3.15	1886	0.19	1881	3.07	6.66	1882	0.89	1885	2.66	5.24	1878	0.85	1885	3.30	6.52	1878	1.02	1883	3.99	5.57	1882	2.14	1879	4.37	7.24	1886	2.01	1887	2.90	8.20	1884	0.00	1883,'86					
Ironton	Iron	Mo.	10	2.58	5.30	1880	1.17	1881	3.88	7.45	1883	0.65	1885	2.86	5.97	1880	0.97	1879	3.34	5.90	1878	1.43	1879	5.13	9.55	1882	1.35	1879	5.23	9.15	1885	2.26	1878	3.85	7.00	1884	0.95	1881					
Kansas City	Jackson	Mo.	11	0.92	2.35	1880	0.00	1881	1.90	4.11	1881	0.23	1886	1.71	2.69	1884	0.42	1885	2.95	6.80	1885	1.26	1886	3.54	6.47	1883	1.70	1879	5.49	10.95	1883	2.26	1878	3.42	6.93	1883	0.00	1886					
Keokuk	Iowa	Iow.	12	1.42	3.91	1880	0.17	1878	2.53	6.15	1883	0.53	1879	2.07	3.78	1878	0.17	1885	2.52	4.79	1880	1.00	1887	3.78	7.11	1882	1.35	1881	4.90	9.45	1882	1.55	1887	2.39	4.23	1882	0.65	1886					
Kirksville	Adair	Mo.	13	1.20	3.77	1880	0.00	1881	2.06	4.72	1881	0.40	1879	1.82	3.57	1881	0.01	1885	2.29	5.13	1882	0.98	1886,'87	3.32	4.95	1886	0.78	1881	4.96	12.61	1882	0.42	1878	2.99	5.95	1882	1.26	1878					
Lamar	Barton	Mo.	14	1.31	2.91	1886	0.30	1880	2.69	7.97	1882	*0.70	1885	2.02	3.88	1878	0.75	1879	3.41	6.64	1885	0.69	1881	4.46	6.61	1878	2.74	1887	4.00	6.90	1887	1.46	1884	4.46	7.75	1885	1.40	1881					
Leavenworth	Kas.	15	1.28	2.34	1878	0.44	1881	1.87	4.84	1881	0.54	1879	1.62	3.70	1884	0.31	1885	2.65	6.63	1885	0.42	1879	4.53	7.33	1883	3.04	1879	5.57	10.84	1883	1.69	1880	3.96	9.43	1884	0.55	1886						
Lexington	Lafayette...	Mo.	16	1.48	2.29	1880	0.34	1881	2.26	4.29	1881	0.48	1879	1.59	2.67	1881	0.42	1885	2.96	5.90	1885	0.68	1883	3.92	6.23	1883	2.24	1887	5.66	10.72	1883	0.65	1880	4.34	7.26	1884	0.31	1886					
Louisiana	Pike	Mo.	17	1.47	*3.00	1886	0.00	1881	2.92	6.55	1882	0.30	1879	2.16	4.52	1878	0.10	1885	2.55	6.00	1885	1.07	1884	3.52	6.37	1880	0.92	1879	4.63	9.75	1883	1.05	1878	2.06	5.28	1884	0.01	1886					
Mascoutah	St. Clair	Ills.	18	1.73	2.87	1882	0.27	1881	3.59	6.54	1882	1.28	1885	2.99	5.03	1887	0.56	1885	3.12	4.67	1878	1.00	1879	3.88	5.81	1886	1.08	1879	3.91	6.69	1883	1.26	1878	3.84	4.84	1882	0.37	1886					
Mexico	Audrian	Mo.	19	1.57	2.91	1885	0.26	1881	2.88	6.32	1882	0.63	1879	2.21	4.37	1884	0.38	1879	3.18	5.20	1885	1.83	1881	3.70	6.35	1880	1.64	1879	4.57	6.67	1885	2.06	1887	3.22	6.75	1884	0.03	1886					
Miama	Saline	Mo.	20	1.55	3.05	1886	0.36	1881	2.51	4.52	1881	0.43	1879	1.90	3.89	1878	0.45	1885	3.37	7.25	1885	1.52	1880,'83	4.07	6.29	1883	1.95	1887	6.46	11.45	1883	1.07	1880	4.62	14.17	1884	0.20	1886					
Oregon	Holt	Mo.	21	1.56	3.03	1886	0.71	1882	2.00	5.25	1881	0.48	1879	1.50	2.71	1886	0.40	1885	3.55	5.80	1882	2.15	1887	4.02	6.14	1881	1.90	1885	5.70	14.94	1883	3.08	1887	4.18	7.18	1878	0.20	1886					
Pierce City	Lawrence...	Mo.	22	1.73	2.60	1880	0.90	1884	4.21	7.65	1883	0.90	1885	2.56	4.00	1882	0.60	1879	4.04	6.80	1880,'85	1.80	1881	4.69	6.70	1881	2.20	1886	5.09	7.40	1886	3.40	1882	5.67	9.30	1883	2.00	1881					
Pleasant Hill	Cass	Mo.	23	1.23	2.20	1880	0.15	1881	2.29	4.65	1881	0.40	1879	1.67	2.55	1881	0.50	1885	3.42	10.05	1885	*1.50	1881	3.70	6.65	1886	0.91	1884	4.87	8.90	1883	2.35	1880	3.45	7.05	1883	0.00	1886					
Savannah	Andrew	Mo.	24	1.26	2.12	1886	0.57	1881	1.70	4.22	1881	0.40	1886	1.47	*2.80	1878	*0.40	1879,'85	3.11	5.90	1882	*2.00	1887	3.75	6.50	1883	1.80	1886	5.04	9.32	1883	2.60	1886	3.25	*6.60	1879	0.30	1886					
Sedalia	Pettis	Mo.	25	1.74	4.01	1885	0.19	1881	2.55	4.95	1882	0.65	1879	1.95	3.27	1881	0.43	1879	3.21	5.09	1885	1.40	1881	4.27	6.51	1886	0.97	1879	5.76	8.92	1885	2.11	1880	3.98	7.83	1883	0.62	1886					
Shelbina	Shelby	Mo.	26	1.49	2.90	1886	0.03	1881	2.41	4.30	1883	*0.70	1879	2.13	*3.80	1878	0.23	1885	2.21	5.00	1882	0.81	1880	3.63	*6.10	1878	*1.20	1879	4.82	8.61	1885	1.43	1887	3.61	7.15	1883	0.01	1886					
Springfield	Greene	Mo.	27	1.75	2.80	1885	*0.70	1884	3.34	7.29	1882	0.66	1879	2.32	3.27	1878	1.40	1879	3.75	6.04	1878	*2.00	1880	5.71	9.30	1886	2.59	1879	4.58	6.65	1887	2.67	1884	4.68	9.22	1884	1.18	1879					
St. Charles	St. Charles.	Mo.	28	1.69	3.50	1886	0.25	1881	3.65	8.01	1882	0.80	1885	2.50	4.25	1884	0.50	1885	3.05	4.60	1885	1.45	1886	3.64	5.90	1881	0.81																

* Approximated.

MISSOURI RAINFALL (Continued).

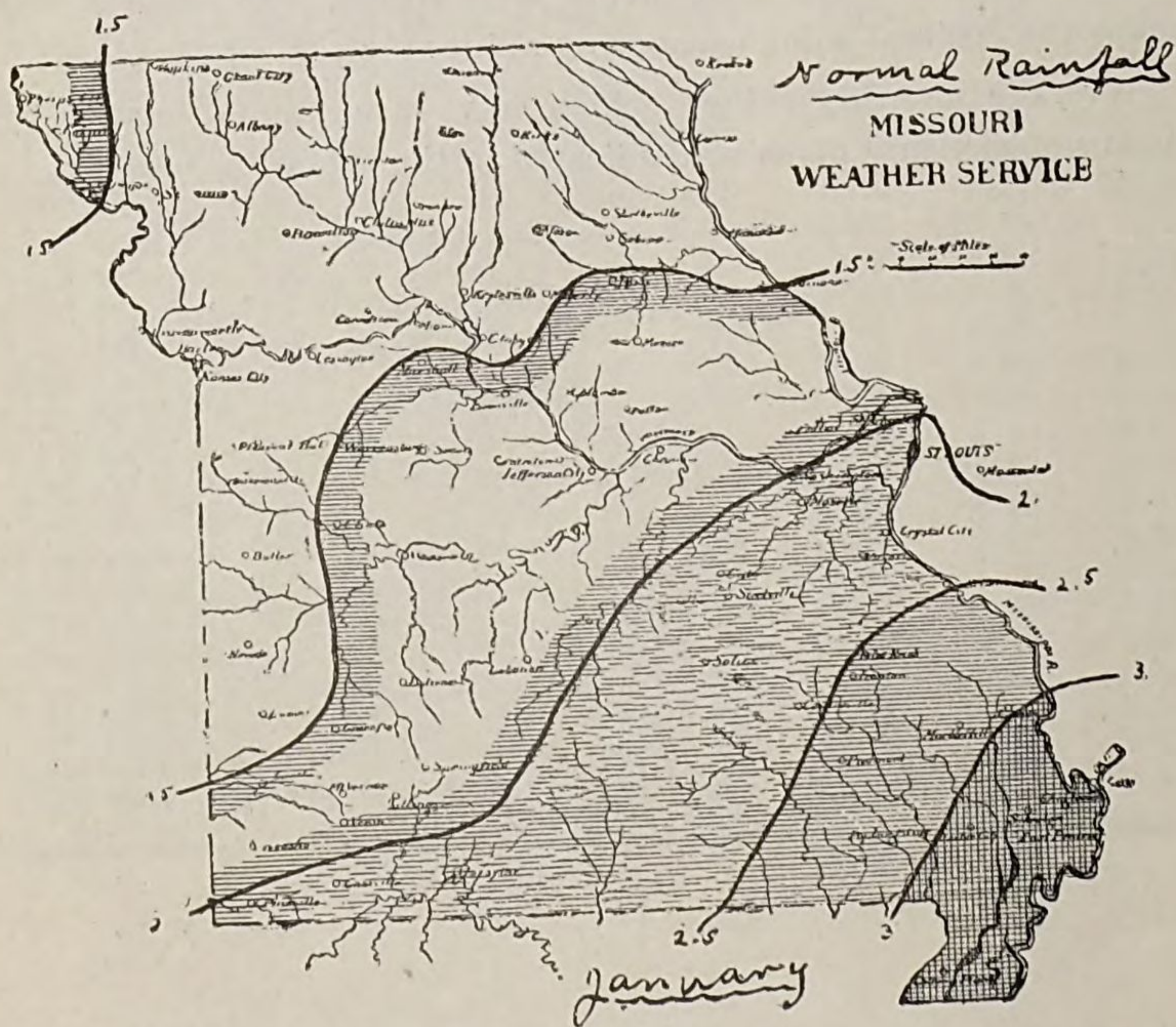
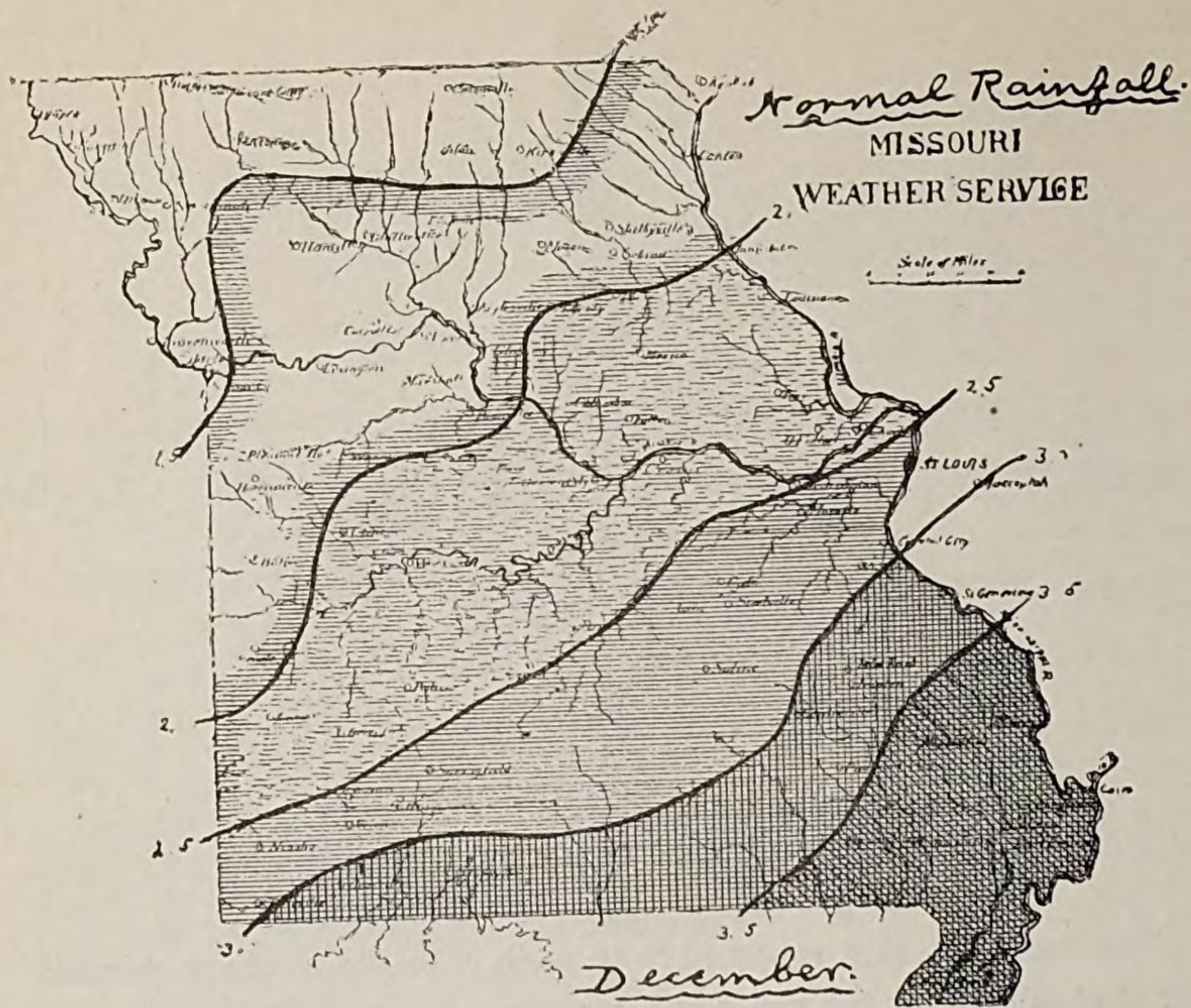
STATION.	COUNTY.	State	Number.	AUGUST.					SEPTEMBER.					OCTOBER.					NOVEMBER.					DECEMBER.					Average Annual Rainfall.	Maximum Annual Rainfall.	Year.	Minimum Annual Rainfall.	Year.	SPRING.	SUMMER.	AUTUMN.	WINTER.
				Average.	Max.		Min.		Average.	Max.		Min.		Average.	Max.		Min.		Average.	Max.		Min.		Average.	Max.		Min.							March	June.	Sept.	Dec.
					Amt.	Year.	Amt.	Year.		Amt.	Year.	Amt.	Year.		Amt.	Year.	Amt.	Year.		Amt.	Year.	Amt.	Year.		Apr.	July.	Oct.	Jan.									
Boonville.....	Cooper.....	Mo.	1	2.15	4.38	1880	0.05	1879	4.79	10.13	1884	0.25	1883	3.43	8.43	1882	0.74	1879	2.40	5.98	1881	0.63	1878	1.90	3.00	1887	0.78	1886	40.55	54.85	1882	28.56	1879	10.85	12.41	10.62	6.67
Cairo.....	.....	Ills.	2	2.75	7.05	1879	0.11	1881	2.88	5.02	1884	0.34	1883	3.13	6.97	1883	0.38	1887	4.06	5.96	1882	2.41	1884	3.88	8.99	1884	1.74	1886	43.13	61.58	1882	26.75	1887	10.79	10.23	10.07	12.04
Carthage.....	Jasper.....	Mo.	3	3.43	6.42	1883	0.52	1878	3.21	5.00	1880	0.40	1883	4.11	11.76	1883	0.88	1886	2.03	4.36	1881	0.84	1885	2.25	6.91	1884	0.89	1882	38.93	53.67	1883	28.71	1879	9.41	13.45	9.35	6.72
Centreville.....	Reynolds.....	Mo.	4	3.74	10.27	1879	0.71	1881	2.73	6.26	1885	0.64	1883	2.77	7.50	1883	0.43	1884	4.28	6.82	1879	1.30	1884	3.00	7.22	1884	1.82	1883	42.66	55.02	1883	34.43	1887	9.97	13.75	9.78	9.16
Chamois.....	Osage.....	Mo.	5	2.02	5.13	1885	*0.25	1881	4.16	8.93	1881	0.35	1883	2.92	8.70	1883	1.00	1886,'87	2.97	8.34	1881	0.60	1885	2.24	4.37	1884	0.75	1886	36.33	43.52	1882	21.08	1880	9.73	9.31	10.05	7.24
Glasgow, Morrison Observatory..	Howard.....	Mo.	6	2.23	6.08	1880	0.37	1883	4.02	8.38	1884	0.49	1883	3.32	7.58	1883	1.42	1887	1.51	3.96	1882	0.46	1878	1.90	4.20	1878	0.41	1886	33.06	47.96	1884	23.65	1879	8.28	10.73	8.85	5.22
Glasgow.....	Howard.....	Mo.	7	2.19	6.00	1885	0.23	1879	4.39	8.64	1884	0.39	1883	3.54	7.93	1883	1.50	1880	1.89	4.13	1882	0.50	1878	1.97	3.82	1878	0.40	1886	35.43	48.50	1884	26.09	1879	8.19	11.50	9.82	5.92
Greenfield.....	Dade.....	Mo.	8	3.02	7.00	1885	0.10	1882	3.47	7.60	1885	0.00	1883	2.91	8.30	1881	1.05	1879	1.70	3.40	1881	0.60	1885	1.80	3.80	1884	0.97	1882	33.75	42.60	1885	26.10	1879	8.79	11.98	8.08	4.90
Hermann.....	Gasconade..	Mo.	9	2.60	4.71	1885	0.20	1881	4.60	8.73	1885	1.55	1883	2.15	5.58	1881	0.28	1887	2.97	5.36	1879	1.46	1878	2.16	3.52	1883	1.15	1886	36.58	46.78	1884	27.61	1883	9.95	9.87	9.72	7.03
Ironton.....	Iron.....	Mo.	10	2.99	8.30	1879	1.20	1884	2.87	4.90	1886	0.75	1883	3.26	8.50	1883	0.70	1887	4.67	8.72	1879	1.69	1878	3.33	7.47	1884	1.92	1883	43.99	56.64	1883	33.31	1887	11.33	12.07	10.80	9.79
Kansas City.....	Jackson.....	Mo.	11	4.09	12.26	1880	0.49	1879	4.41	8.99	1885	0.82	1883	3.69	7.78	1883	0.75	1878	2.19	4.97	1879	0.51	1878	1.42	3.34	1878	0.00	1880	35.73	49.52	1885	19.04	1886	8.20	13.00	10.29	4.24
Keokuk.....	 [la. or Iowa..	Mo.	12	3.59	5.98	1885	0.86	1881	2.82	4.25	1884	1.12	1879	3.36	8.01	1881	0.28	1879	1.88	3.91	1879	0.88	1885	1.83	3.91	1884	0.67	1880	33.09	41.24	1882	22.51	1879	8.37	10.88	8.06	5.78
Kirksville.....	Adair.....	Mo.	13	3.58	4.54	1884	0.98	1881	2.75	5.05	1881	1.12	1883	3.70	11.30	1881	1.38	1879	1.68	3.65	1879	0.25	1885	1.39	2.53	1884	0.22	1886	31.73	45.43	1882	22.20	1886	7.43	11.53	8.13	4.65
Lamar.....	Barton.....	Mo.	14	3.72	7.20	1880	1.57	1883	4.40	13.24	1885	0.25	1883	3.04	7.83	1883	0.88	1878	1.93	4.45	1879	0.49	1885	2.09	*5.00	1884	0.82	1886	37.53	48.75	1885	33.48	1886	9.89	12.18	9.37	6.09
Leavenworth.....	.....	Kas.	15	3.38	7.11	1887	0.18	1879	3.98	7.65	1885	0.95	1882	3.93	8.31	1883	1.16	1878	2.48	7.85	1879	1.10	1886	1.35	2.55	1887	0.40	1880	36.60	44.72	1884	22.25	1886	8.80	12.91	10.39	4.50
Lexington.....	Lafayette.....	Mo.	16	2.96	5.14	1880	0.44	1879	4.23	6.84	1884	1.25	1883	3.26	5.42	1883	1.58	1878	2.01	4.10	1882	0.50	1878	2.06	4.00	1878	0.51	1886	36.74	45.50	1885	23.73	1886	8.47	12.96	9.50	5.80
Louisiana.....	Pike.....	Mo.	17	2.54	5.12	1886	0.00	1881	3.34	8.46	1886	0.19	1883	2.86	8.95	1881	0.41	1887	2.20	3.95	1881	1.30	1884	2.13	3.62	1887	0.61	1883	32.37	41.02	1882	21.50	1879	8.23	9.23	8.40	6.52
Mascoutah.....	St. Clair.....	Ills.	18	2.28	4.35	1885	0.54	1881	3.06	7.25	1886	0.03	1883	3.42	7.81	1883	0.76	1876	2.84	6.65	1881	0.71	1878	2.99	5.38	1884	1.55	1881	37.65	43.09	1883	31.48	1879	9.99	10.03	9.32	8.31
Mexico.....	Audrian.....	Mo.	19	2.42	5.58	1878	0.09	1881	3.89	8.21	1884	0.31	1883	2.39	5.39	1881	0.73	1877	2.68	5.83	1879	1.26	1878	2.48	4.02	1887	0.88	1886	35.19	46.09	1882	27.04	1887	9.09	10.21	8.96	6.93
Miami.....	Saline.....	Mo.	20	3.43	6.52	1884	0.59	1883	4.34	6.59	1884	*0.80	1883	3.67	6.47	1883	1.63	1878	1.97	*3.00	1882	0.54	1878	2.23	3.68	1884	0.70	1886	40.12	55.68	1884	31.13	1880	9.34	14.51	9.98	6.29
Oregon.....	Holt.....	Mo.	21	2.59	6.61	1880	0.67	1882	3.32	4.97	1887	0.74	1882	4.22	6.50	1883	1.85	1887	2.02	7.81	1879	0.48	1885	1.37	2.19	1878	0.81	1886	36.03	46.91	1883	29.57	1885	9.07	12.47	9.56	4.93
Pierce City.....	Lawrence.....	Mo.	22	3.71	7.20	1885	0.00	1882	3.38	7.30	1884	0.20	1883	4.61	9.50	1882	1.40	1885	3.19	6.00	1879	1.30	1878	2.82	10.10	1884	1.00	1882,'85	45.70	51.95	1883	36.60	1879	11.29	14.47	11.18	8.76
Pleasant Hill.....	Cass.....	Mo.	23	2.55	5.50	1880	0.20	1879	3.56	10.30	1884	1.31	1879	3.57	8.13	1883	1.27	1878	2.05	*4.30	1879	0.62	1878	1.88	3.98	1878	0.40	1880	34.24	48.10	1883	23.95	1886	8.79	10.87	9.18	5.40
Savannah.....	Andrew.....	Mo.	24	2.57	6.81	1880	0.75	1885	3.06	5.25	1887	*0.70	1882	4.13	7.75	1881	*2.00	1878	2.10	8.90	1879	0.70	1878	1.36	2.20	1884	0.45	1886	32.79	41.21	1881	22.16	1886	8.33	10.86	9.29	4.32
Sedalia.....	Pettis.....	Mo.	25	1.67	2.81	1878	0.60	1879	4.50	10.54	1884	*0.40	1883	3.09	7.07	1883	0.51	1878	1.96	3.17	1881	0.53	1885	2.00	4.77	1884	0.53	1886	36.68	49.84	1884	23.28	1880	9.43	11.41	9.55	6.29
Shelbina.....	Shelby.....	Mo.	26	2.66	4.70	1884,'86	0.02	1881	3.94	7.50	1886	0.20	1883	3.72	9.90	1883	*0.50	1879	1.87	3.60	1879	0.18	1884	1.81	4.20	1884	0.76	1880	34.30	43.98	1883	24.75	1879	7.97	11.09	9.53	5.71
Springfield.....	Greene.....	Mo.	27	2.94	4.43	1878	1.50	1879	2.79	6.15	1885	*0.40	1883	3.40	7.62	1882	0.40	1886	2.99	6.30	1882	0.52	1878	2.59	7.62	1884	0.75	1886	40.84	55.43	1882	25.06	1879	11.78	12.20	9.18	7.68
St. Charles.....	St. Charles..	Mo.	28	2.76	5.70	1885	0.60	1881	2.75	5.10	1886	0.00	1883	2.77	6.40	1881	0.70	1886	3.32	6.60	1881	1.10	1878	2.10	3.70	1884	0.80	1881	35.40	44.30	1884	29.11	1878	9.19	9.93	8.84	7.44
St. Joseph.....	Buchanan.....	Mo.	29	2.96	6.98	1880	0.51	1882																													

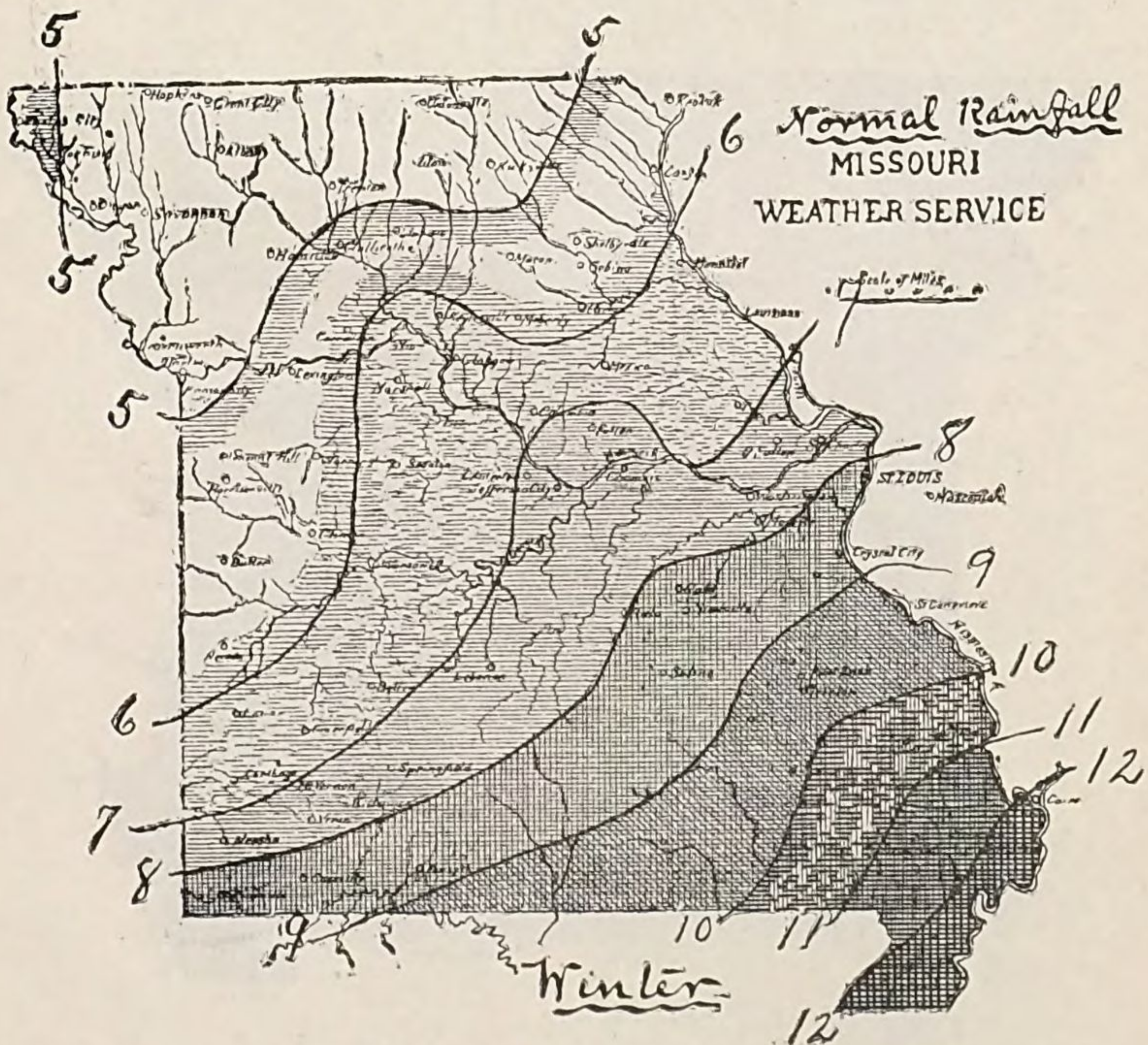
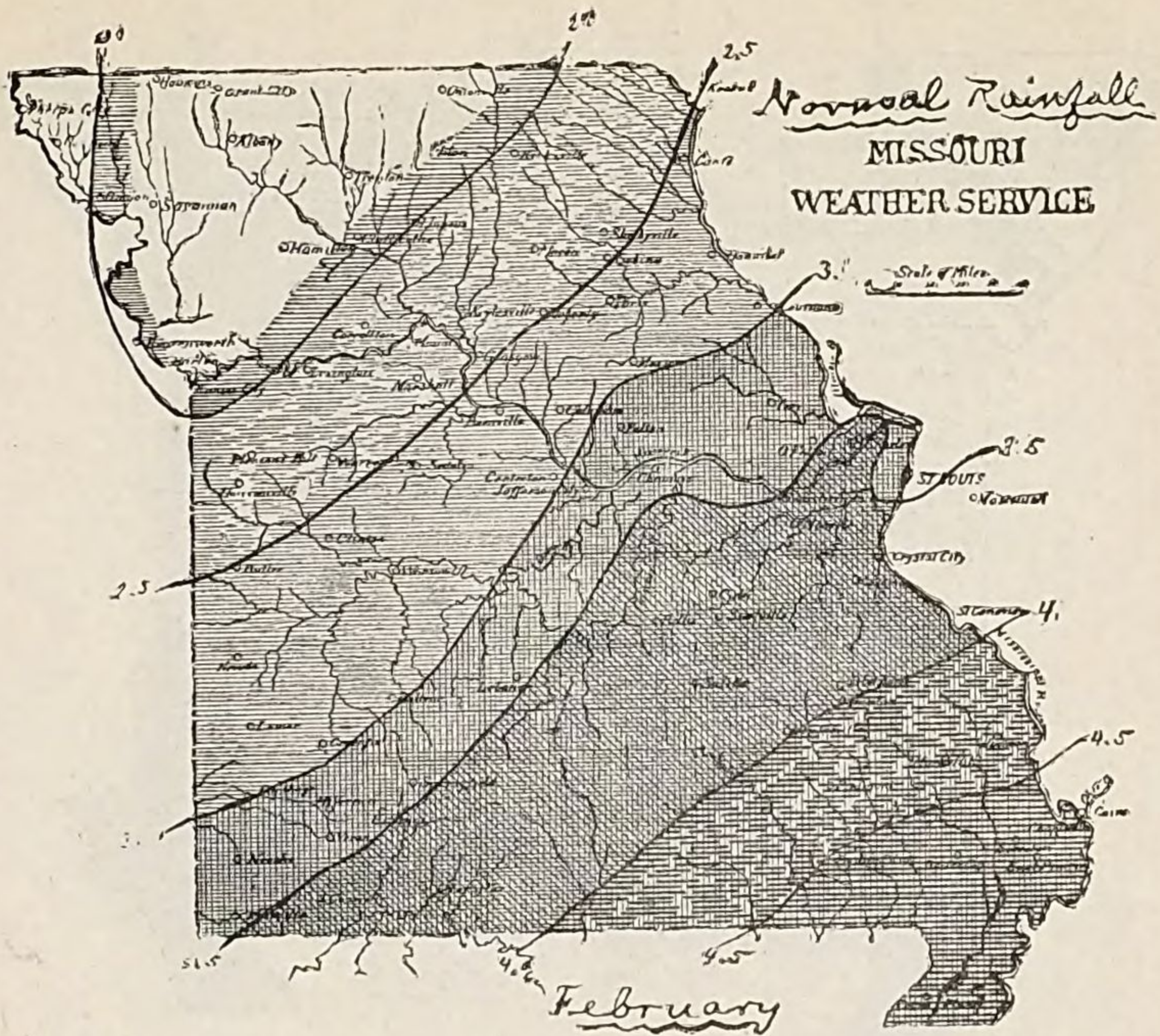
EXPLANATION OF THE PLATES.

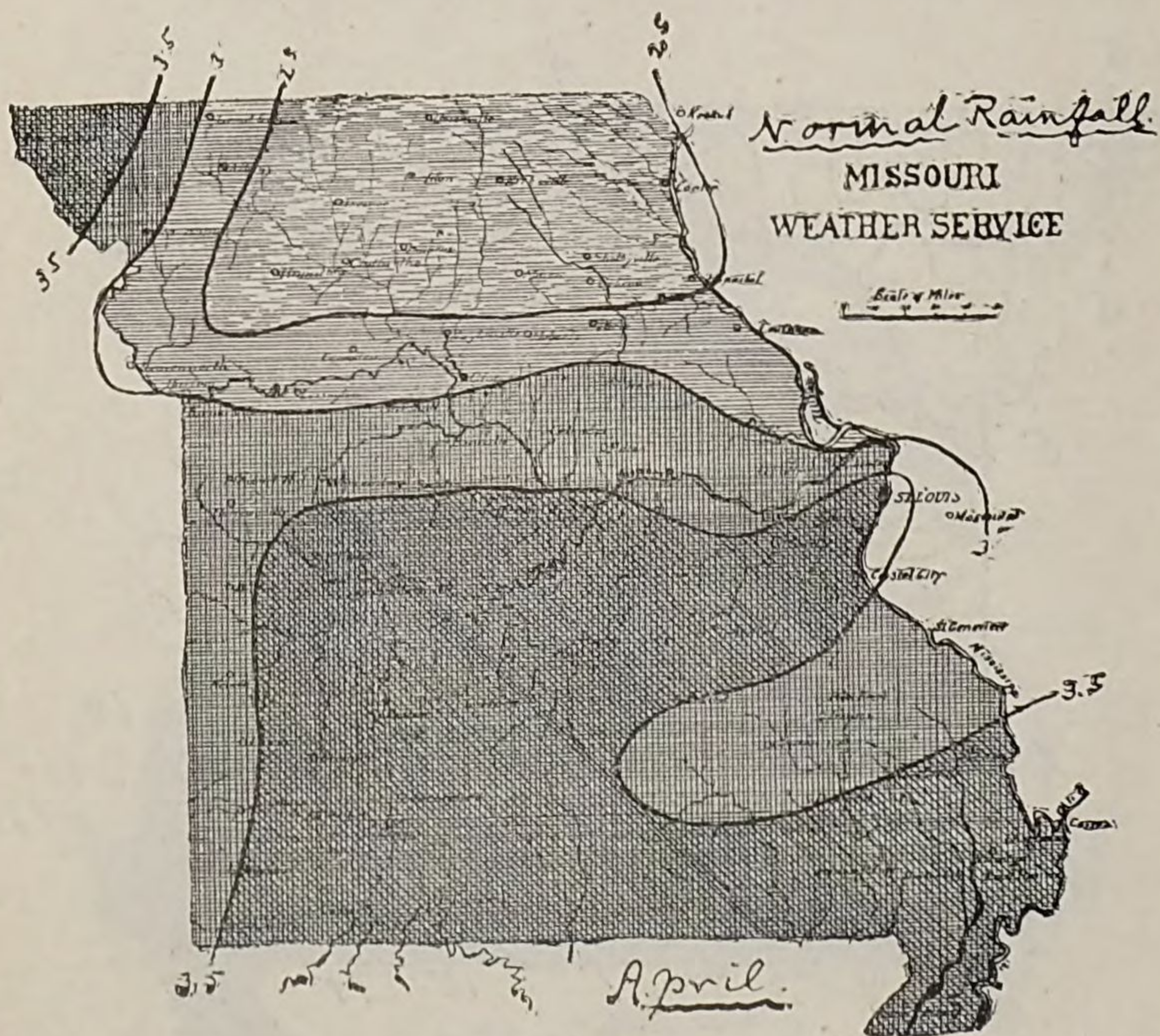
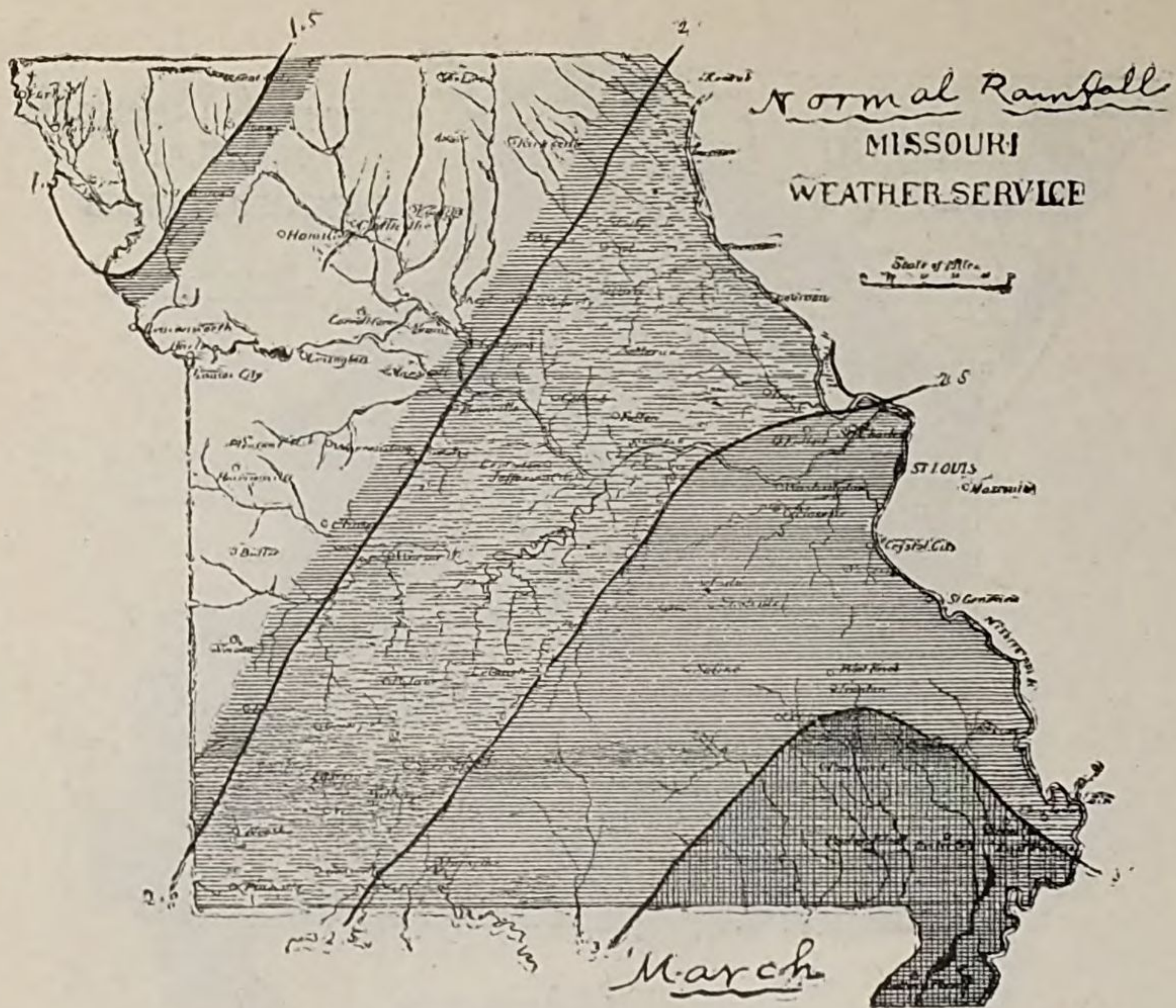
The monthly rain maps give in each case the average rainfall for that month for ten years ending December 31st, 1887.

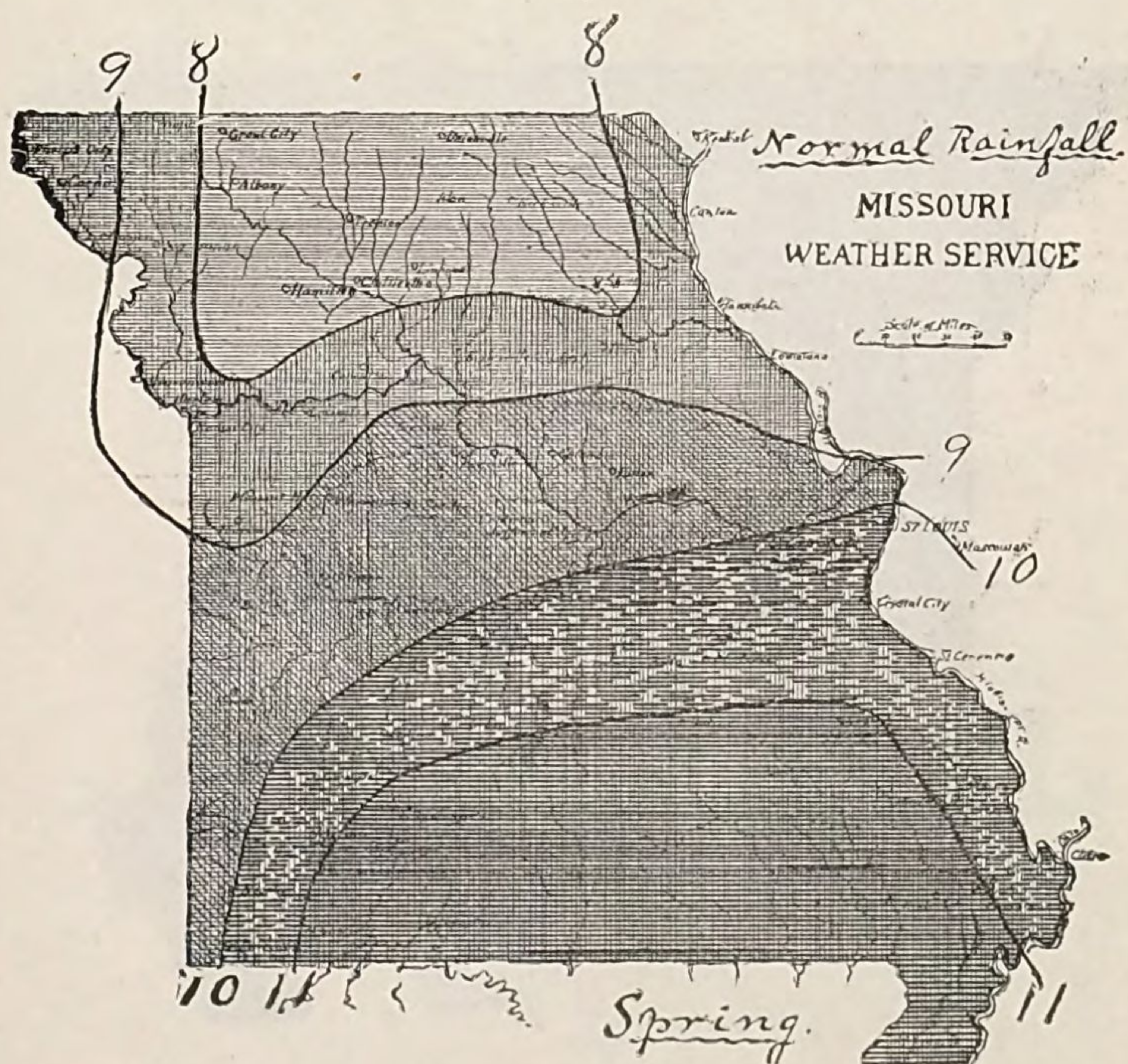
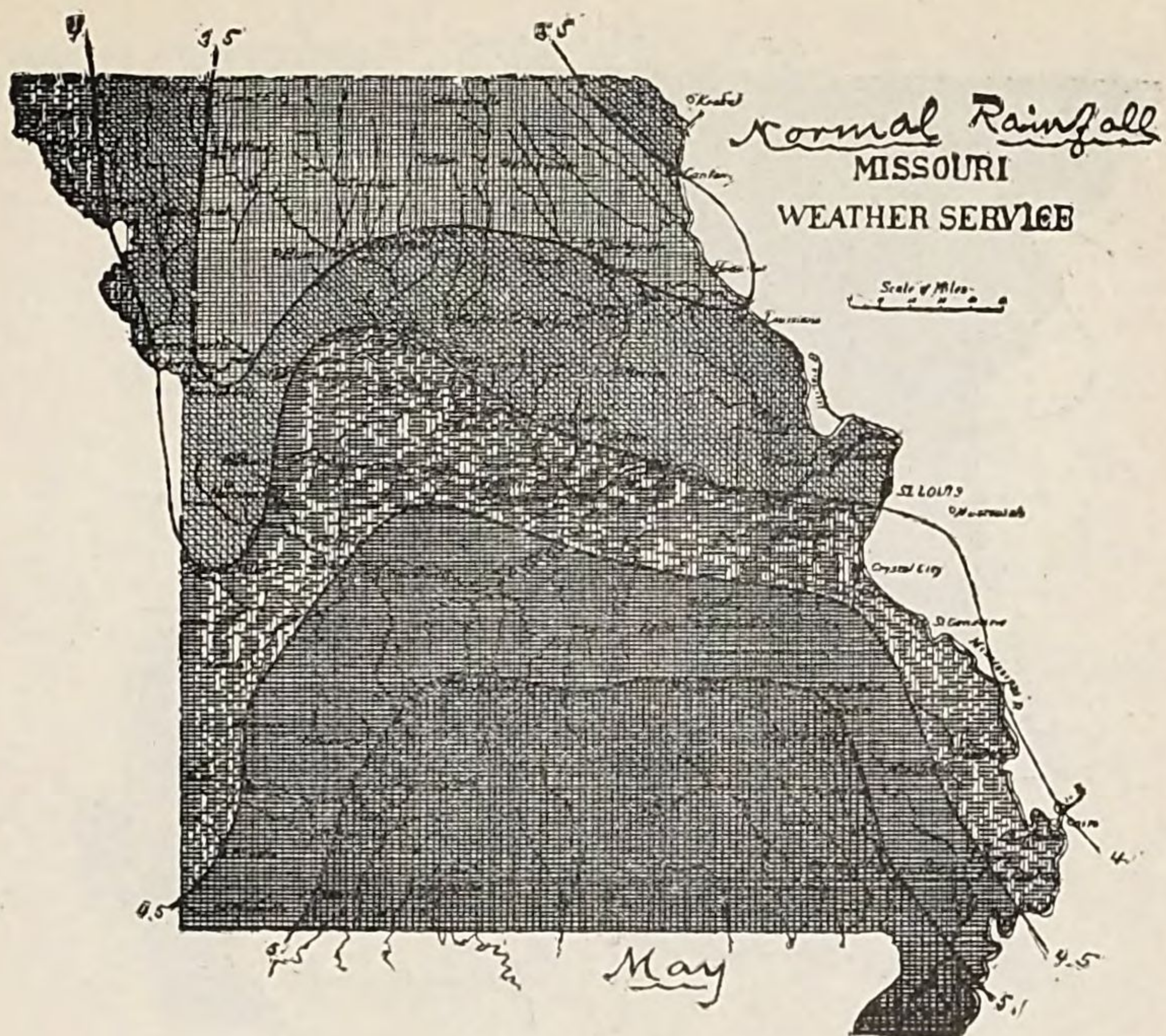
The rainfall is given in inches and tenths. On some of the maps the decimal point was not reproduced in the copper plate.

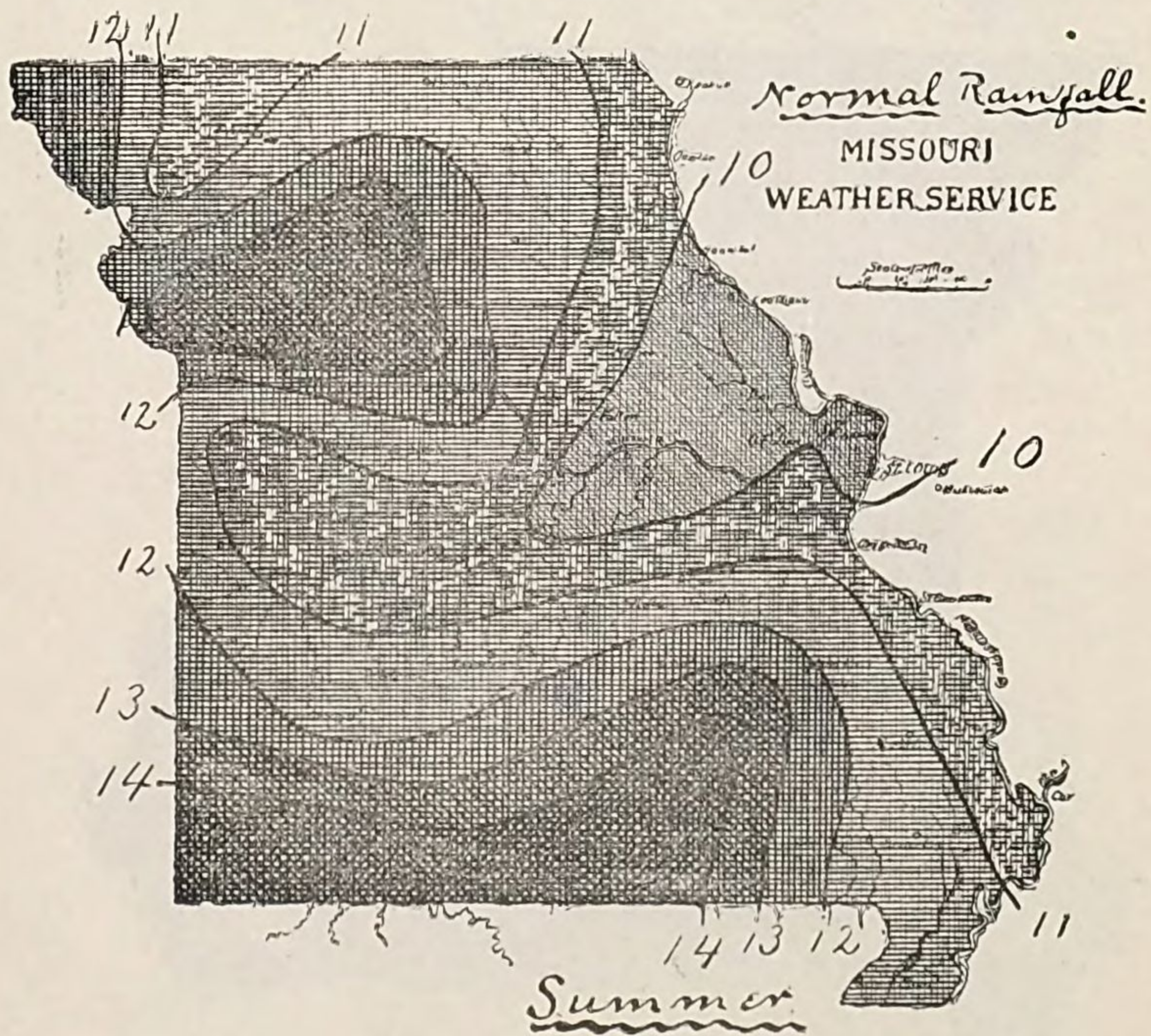
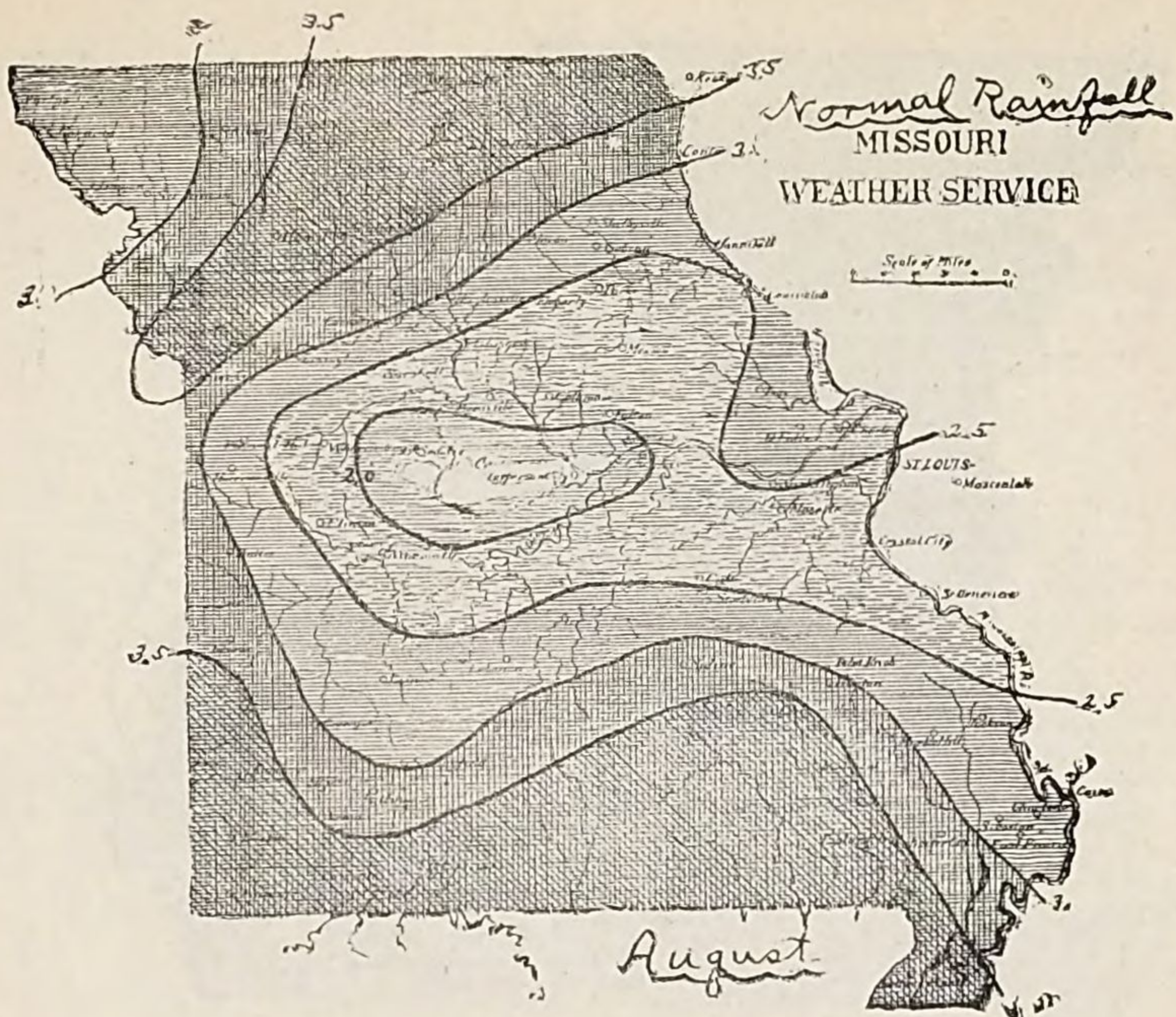
Average monthly values which have been approximated by means of monthly maps are indicated in the tables by asterisks.

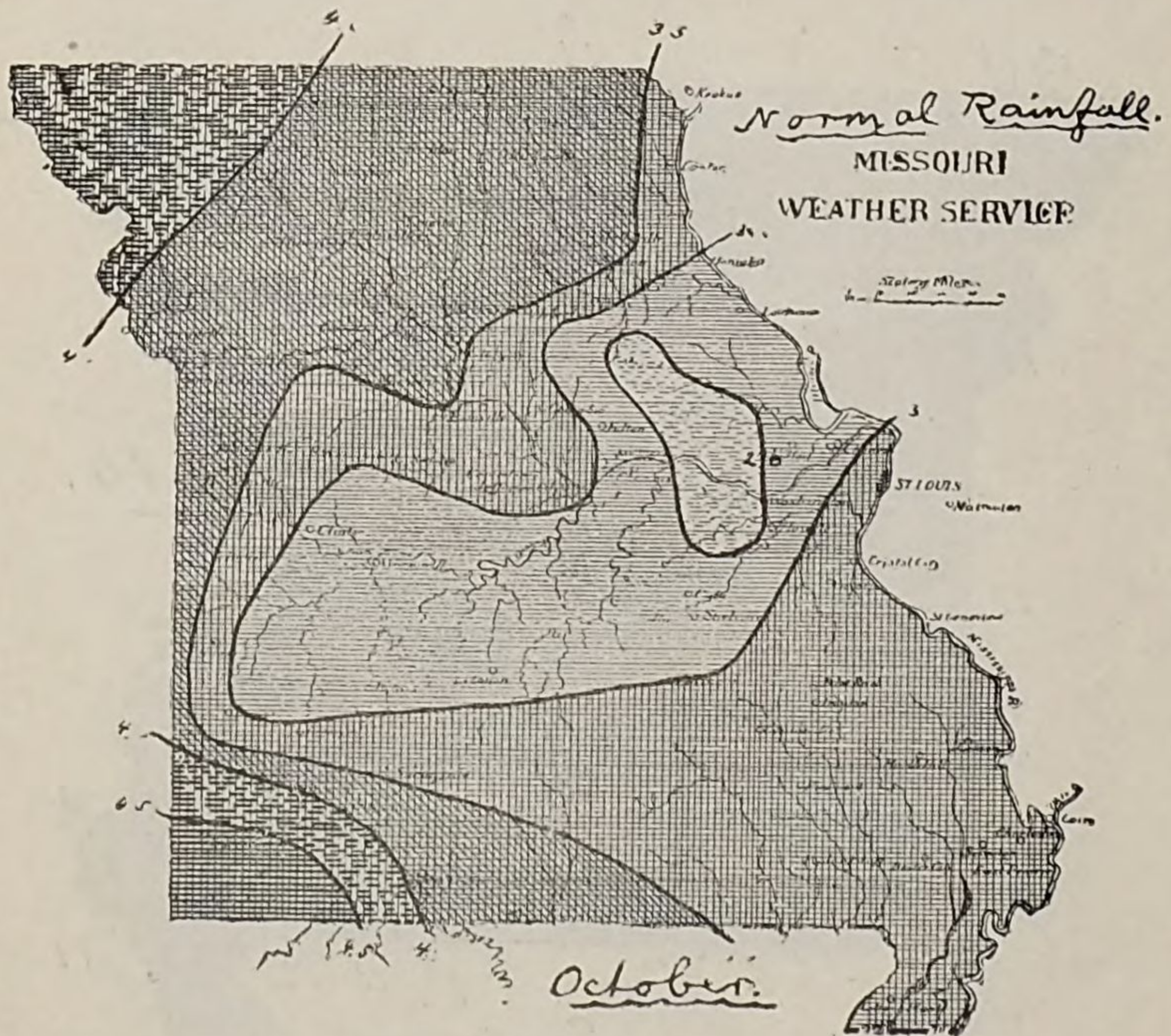
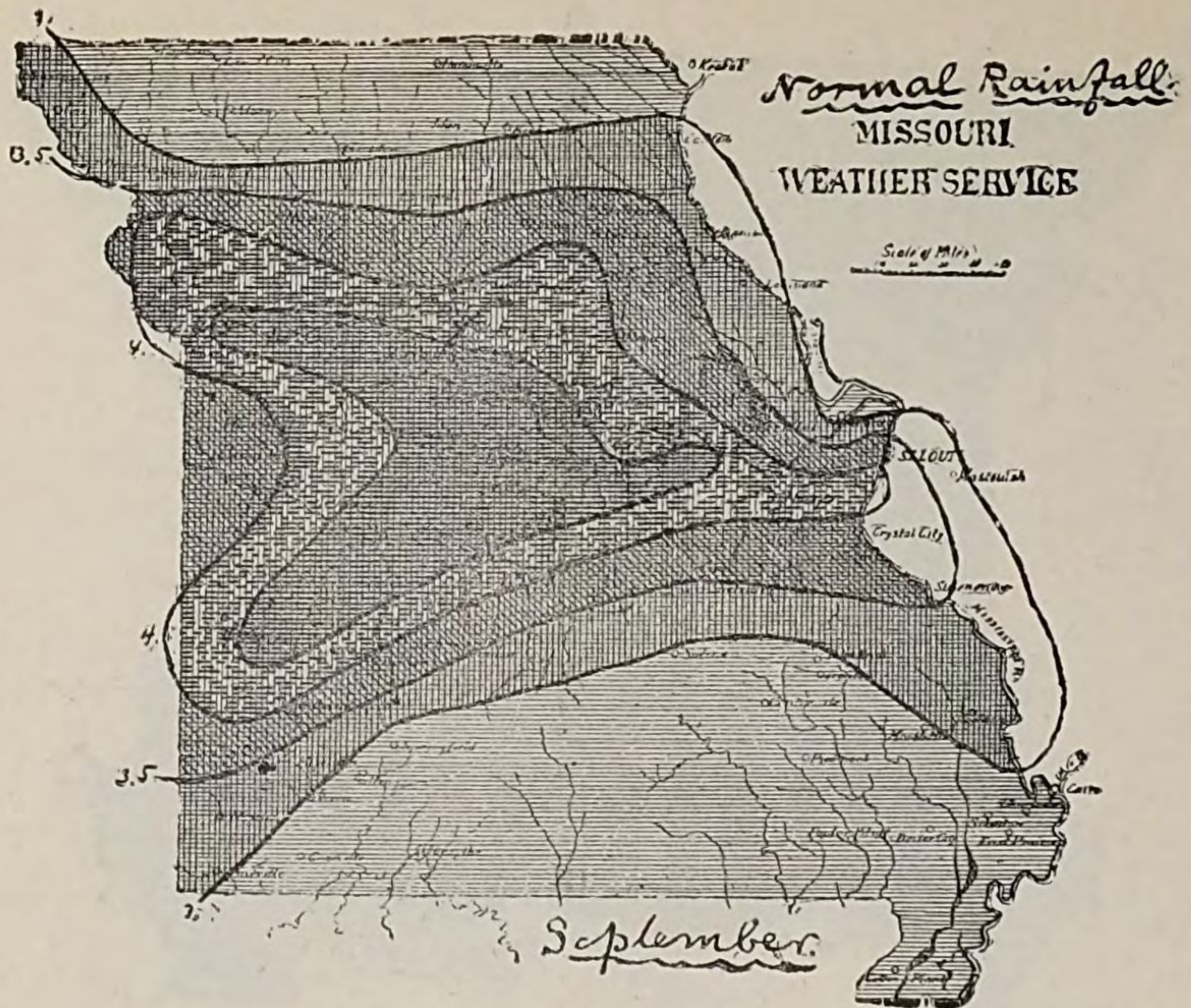


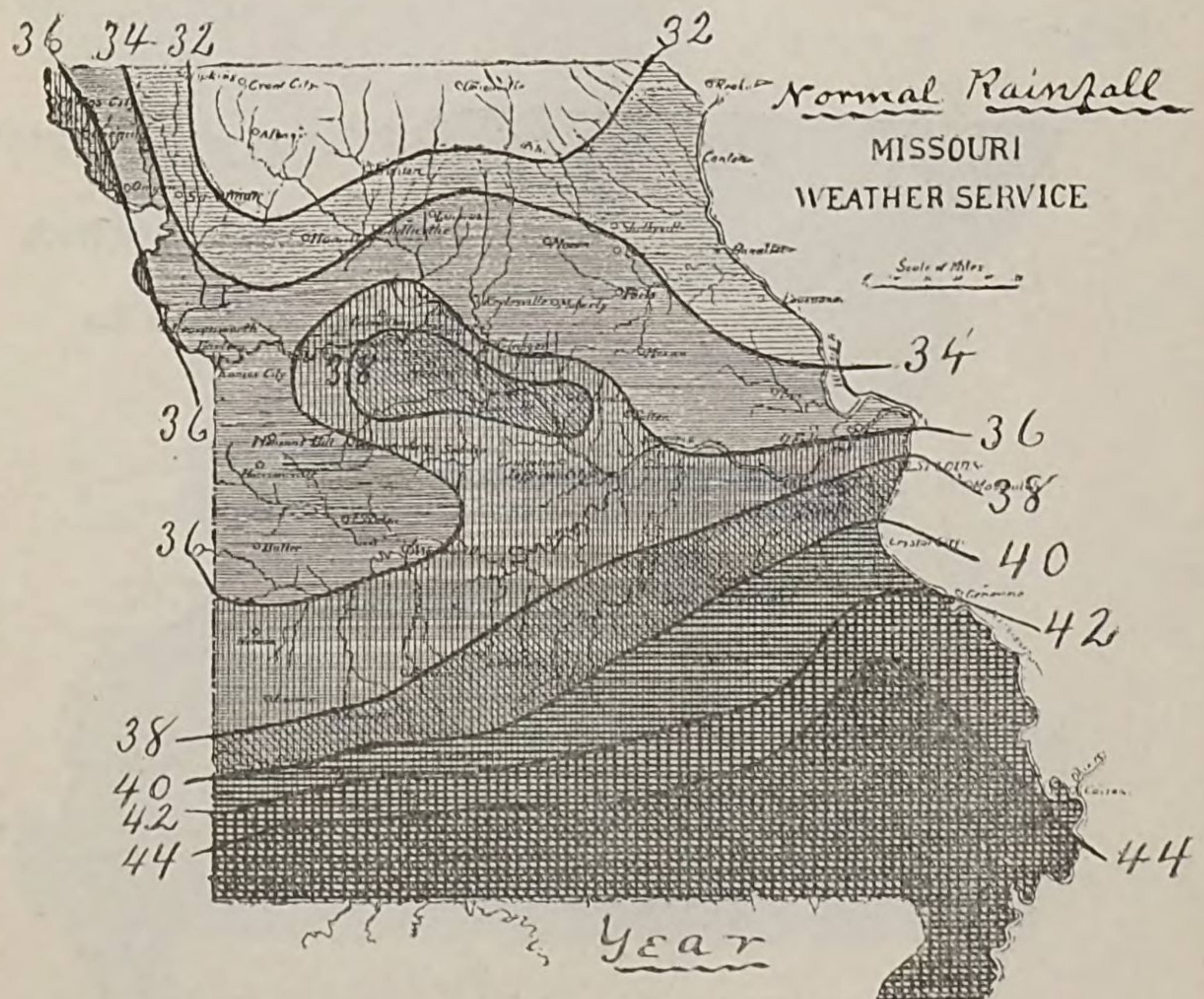
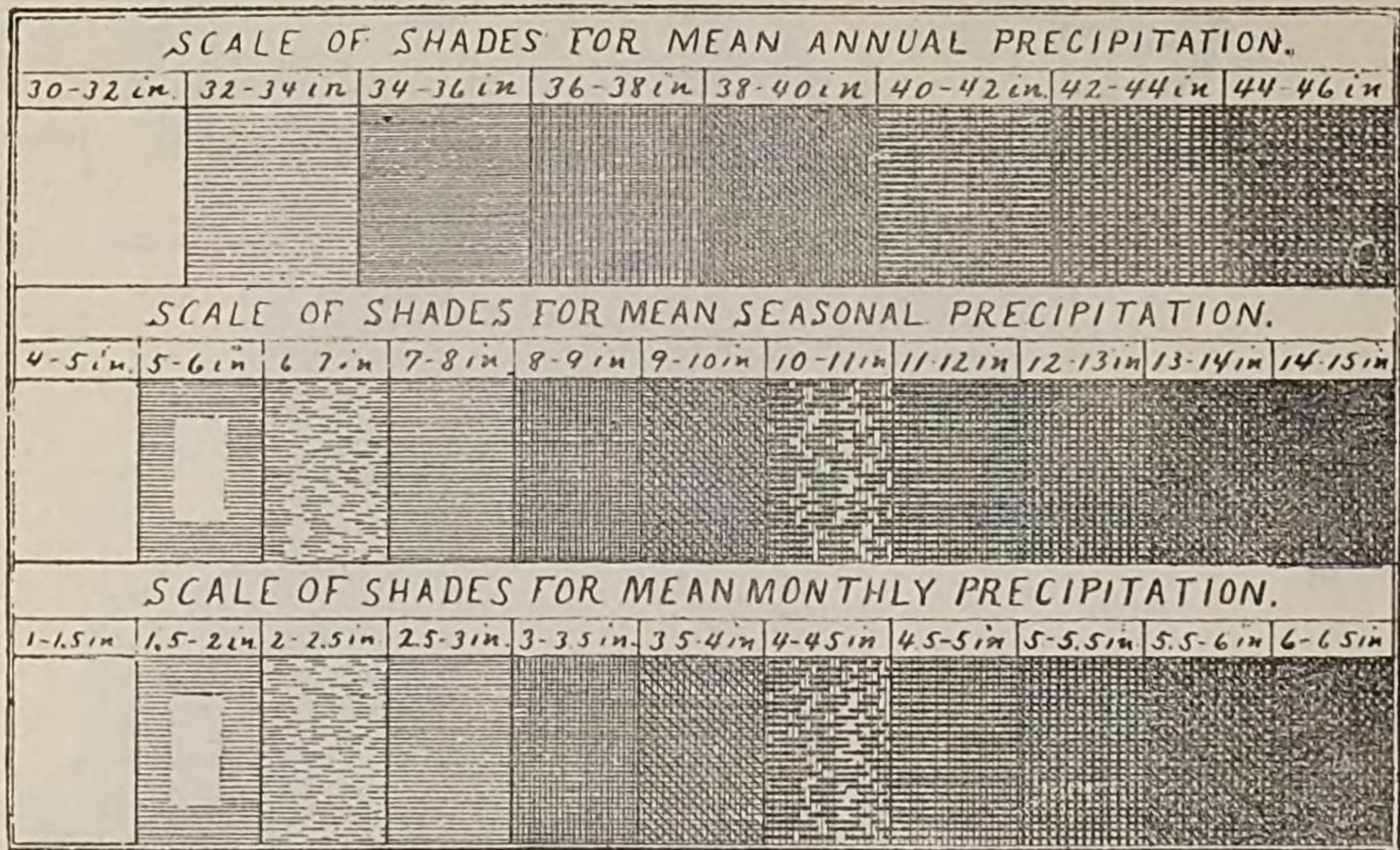












*ON THE OUTPUT OF THE NON-CONDENSING STEAM
ENGINE AS A FUNCTION OF SPEED AND PRESSURE.*

By FRANCIS E. NIPHER.

*On the Output of the Non-condensing Steam Engine,
as a Function of Speed and Pressure.**

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In the discussion which follows, the engine is supposed to be running at a fixed cut-off, and without change in the throttle. The pressure changes required to produce a change of speed are supposed to be effected by a change in boiler pressure. The effect of the throttle or the governor with automatic cut-off will be pointed out as we proceed.

The difference between the two belt-pulls, or the load on the brake, is represented by w , r being the brake-arm, or radius of the driving-wheel. If the belt-pulls are F' and F'' , then $F' - F'' = w$. It is supposed also that the mean effective pressure required to drive the engine when $w = 0$ is constant for all speeds. In an engine with balanced valves and where the amount of lubrication used increases with the speed, this assumption may be tolerated for a general treatment of the case, although the peculiarities of engines will doubtless cause them to depart from this assumption in a more or less irregular way. Engines are usually built for definite speeds, and often behave poorly when run at widely different speeds from those for which they were designed.

For these reasons, some portions of this treatment cannot lay claim to very great precision. It will serve mainly to present the general conditions of the problem, and may serve as a basis for investigating the peculiarities of individual engines.

Let P_0 = mean effective pressure when $w = 0$,
 P_0 = boiler pressure above atmospheric pressure when $w = 0$.
 P = mean effective pressure with load w .
 R = piston radius,
 l = stroke. n = revolutions per minute.

Then, during one stroke of the engine at uniform speed,

* Read May 20th, 1889.

$$\pi R^2 (P - P_0) l = \pi r w,$$

$$\text{or} \quad P = P_0 + \frac{rw}{R^2 l} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Multiplying this equation by $\frac{2\pi R^2 l n}{33000}$

$$IHP = \frac{2\pi R^2 l n P_0}{33000} + \frac{2\pi r n w}{33000} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The indicated horse-power is equal to the brake horse-power plus the power required to drive the engine alone.

In the equation leading to (1) the second member should strictly contain a term $= f(F' + F'')$ the exact form of which would depend upon how the belt is applied. It is so small that it cannot usually be measured on an indicator card, and is here omitted. It may be inserted, however, without changing the form of any of the succeeding equations.

The equation for brake horse-power is

$$BHP = \frac{2\pi r n w}{33000} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$BHP = \frac{2\pi R^2 l n}{33000} (P - P_0) \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$IHP = \frac{2\pi R^2 l n P}{33000} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Taking IHP , as a function of n and P , and (5) is the equation of an hyperbolic paraboloid, the constant for which is entirely independent of the condition of the engine or the steam with which it is supplied. It depends solely on the geometry of the engine (the unit of power being fixed). It involves only the volume swept through by the piston-face during one stroke. The performance of all engines in which this volume is the same would always be represented by points on a common surface. These points may be made to move about in any arbitrary manner by variations in boiler pressure and load.

If the boiler pressure is held constant, then n becomes some definite function of w , and the point representing the perform-

ance of any engine would traverse some definite line upon the surface.

Equation (4) which represents brake horse-power, is also the equation of an hyperbolic paraboloid, having the same constant as the one represented by (5). The two surfaces have a common pressure axis, and the coördinate planes of $\text{III}P$, n for the two surfaces are separated by the distance P_0 . On each of these surfaces, a condition of constant load, w , would be represented by some definite line, and (3) which is the ordinary formula for $B \text{ III}P$ is a projection of that line upon the coördinate plane of $\text{III}P$, n .

For any definite values of n and P , a vertical ordinate drawn through the surfaces of $B \text{ III}P$ and $I \text{ III}P$ would determine simultaneous values of brake and indicated horse-power. The distance between the surfaces measured on this ordinate would represent the power consumed in the engine itself. Passing a plane through these surfaces at right-angles to the speed axis, the intersections with the two surfaces would be parallel lines. The distance between these lines measured parallel to the $\text{III}P$ axis is constant, and represents as stated the power consumed in the friction. It is constant for all loads, as experiment shows it to be, and increases uniformly with the speed at constant pressure, or by (4) and (5),

$$\left[\frac{d(I \text{ III}P)}{dP} \right]_n = \left[\frac{d(B \text{ III}P)}{dP} \right]_n = \frac{2\pi R^2 l n}{33000}$$

$$\left[\frac{d(I \text{ III}P)}{dn} \right]_P = \frac{2\pi R^2 l P}{33000}$$

$$\left[\frac{d(B \text{ III}P)}{dn} \right]_P = \frac{2\pi R^2 l (P - P_0)}{33000} = \frac{2\pi r w}{33000}$$

In Fig. 1, oP' and oA'' are the axes of pressure, and $\text{III}P.AA''$ is the line of atmospheric pressure, and VV' is the vacuum line. The lines op'' and $P_0 p'$ are rectilinear elements in the surfaces of $I \text{ III}P$ and $B \text{ III}P$ at constant speed, the ordinates Pp'' and Pp' representing simultaneous values. If the mean effective pressure were reduced to zero, the engine being driven at the same speed by means of the belt, the power required is represented by

of cut-off. The mean effective pressure would be less, and the back pressure would be h . Increasing the boiler pressure, the back pressure increases by a quantity which is proportional to the speed.

Measuring P'_0 from the atmospheric line,

$$P'_0 = cn + P_0 + E + bn \quad . \quad . \quad . \quad . \quad . \quad (7)$$

where cn is the mean back pressure, P_0 the mean effective pressure, E a function of the inverse expansion ratio, and bn is a term applying to the entry port which is entirely analogous to cn . The constants c and b depend upon the size of the ports, b also depending to a less extent upon the pipes connecting the steam-chest and boiler. In a throttle governor, the value of b is changed in order to change mean effective pressure. In a governor which varies the cut-off, both E and b are changed by the action of the governor.

The action of any governor changes the inclination of the line V, B in Fig. 1. For a constant boiler pressure P' , if the cut-off comes earlier, or, if the steam is throttled, the line V, B becomes less steep, and the points p' and p'' sink to represent a smaller output.* In Fig. 2, the action of the governor changes the position of the line $w = 0$, and in fact the entire surface of $\Pi\Pi'$ as function of P' .

Making the indicated substitutions in (6)

$$P' = -h + \frac{h + P_0 + \frac{rw}{R^2 l}}{h + P_0} (h + P_0 + E + (b + c)n) \quad . \quad (8)$$

Solving this equation for w ,

$$w = \frac{R^2 l}{r} \left[\frac{(h + P_0)(h + P')}{h + P_0 + E + (b + c)n} - (h + P_0) \right] \quad . \quad . \quad (9)$$

Multiplying (9) by $\frac{2\pi nr}{33000}$

$$B_{HP} = \frac{2\pi R^2 l}{33000} \left[\frac{(h + P_0)(h + P')n}{h + P_0 + E + (b + c)n} - (h + P_0)n \right] \quad (10)$$

* In an experimental engine the head of the screw which controls the steam should be provided with a divided scale like a micrometer.

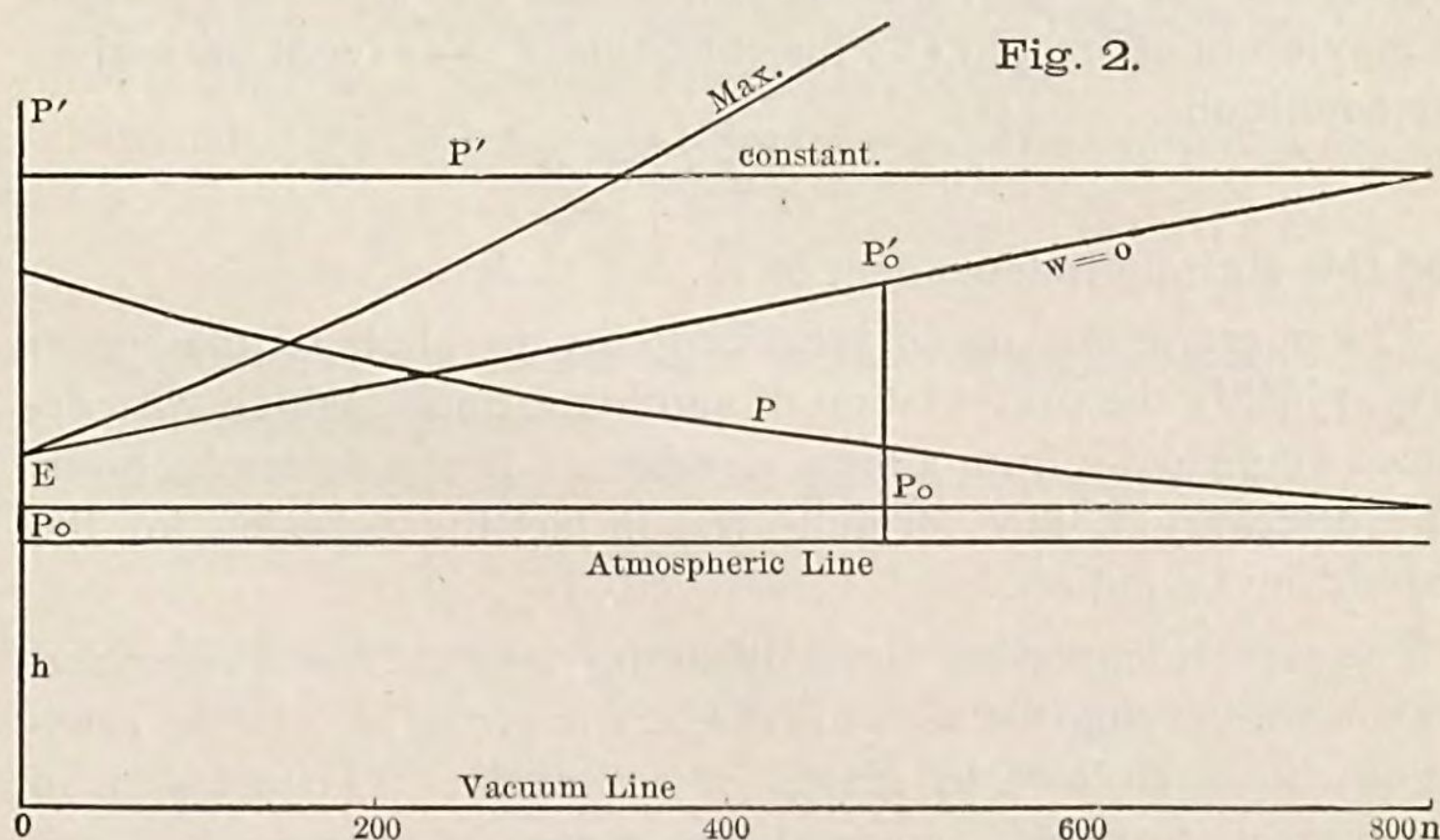
For any constant boiler pressure there will be some definite speed which will make BHP a maximum. The condition is

$$\left[\frac{d BHP}{dn} \right]_{P'} = 0.$$

Imposing this condition we have

$$(h + P') (h + P_0 + E) = [h + P_0 + E + (b + c) n]^2 \quad . \quad . \quad (11)$$

The speed must be such that the boiler pressure required to drive the unloaded engine at that speed, is a mean proportional between the constant boiler pressure under consideration, and the boiler pressure required to start the unloaded engine, [see (7),] all pressures being measured from vacuum. The load corresponding to this maximum is of course found by imposing this condition in (9) by the elimination of n .



Equation (11) gives the relation between n and P' for a maximum output at any boiler pressure P' . It is the equation of a parabola, which crosses the pressure axis at its intersection with the line of zero load (7). The slope of this parabola is

$$\frac{dP'}{dn} = 2(b + c) + 2 \frac{(b + c)^2}{h + P_0 + E} n \quad . \quad . \quad . \quad (12)$$

When $n = 0$ the slope is therefore twice that of the line of zero load.

The value of n in (11) is

$$n = - \frac{h + P_0 + E}{b + c} \pm \frac{1}{b + c} \sqrt{(h + P_0 + E)(h + P')} \quad (13)$$

Hence the vertex of this parabola is at the intersection of the line of zero load (7) with the vacuum line. Its position is

$$\begin{aligned} P' &= -h \\ n'' &= - \frac{h + P_0 + E}{b + c} \end{aligned}$$

This value of n'' is rather large and therefore the part of the parabola which corresponds to a possible range of engine speed will be very nearly a straight line. The axis of the parabola is of course parallel to the pressure axis. It will be observed that all lines of constant load represented by (8) intersect the vertical line (parallel to the W axis) which contains the vertex of the parabola of maximum effort. In (8) the condition $P' = -h$ at once gives the condition

$$n = - \frac{h + P_0 + E}{b + c}$$

and this entirely independent of w .

The observations made regarding the parabola of maximum output justify the presentation of another formula which was deduced empirically from a large number of brake determinations. The discovery of that formula was in fact the occasion for the present investigation.

The experiments were made by taking constant loads on a fixed brake-arm varying the speed of the engine from 200 to 800 revolutions, for each load, by means of a throttle. The pressure of the supply steam was measured by means of a gauge between the throttle and the steam-chest, the cut-off remaining fixed.

The observations for constant load all satisfied, equations of the form

$$P' = a + b'n \quad (14)$$

This equation is identical with (8). Computing from each equation the value of n for a given pressure, these values of n were plotted with their respective values of w , and gave a line

This value of w is somewhat too small to satisfy (11), although as stated the error is probably always too small to have any importance. Substituting these two values of n' and w' in (3) and we undoubtedly have a very close approximation to the maximum output at any pressure P' ,

$$BHP = \frac{1}{2} \frac{\pi}{33000} \cdot \frac{k}{k'} \cdot kr$$

where $\frac{k}{k'}$ is the speed at that pressure when $w = 0$ as computed from (7) and $kr =$ the turning moment which for that pressure must be applied to the shaft in order to bring the engine to rest. This can be computed from (9). It is wr when $n = 0$.

In a similar manner we may represent indicated horse-power as a function of boiler pressure. Solving (6) for P and substituting, as before,

$$P = -h + \frac{(h + P_0)(h + P')}{h + P_0 + E + (b + c)n} \quad (21)$$

It may be remarked in passing that, for a constant value of P' , this is an hyperbola which represents the relation between mean effective pressure and speed, with varying load. The asymptotes of the curve are the vacuum line and the axis of the parabola of maximum output, where

$$n = -\frac{h + P_0 + E}{b + c}$$

The only part of this curve which has any practical significance is that included between the pressure axis and the line where $P = P_0$. This part of the curve is marked P on Fig. 2, P' being the line representing the corresponding fixed boiler pressure. During the operation here considered, the point representing the performance of the engine would travel through a definite path on the surface represented by (4). The hyperbola marked P on Fig. 2 would be a projection of that path on the plane P, n , while the parabola (10) with P' constant would be a projection of that path on the plane HP, n .

The engine might indeed be driven by a belt at a greater speed than that given it by the steam when $w = 0$, and the mean effec-

tive pressure would continually fall as represented by the hyperbola. The part of the curve corresponding to negative values of n has no physical significance. The engine when brought to rest with any fixed load w , by a decrease of boiler pressure, would not reverse if the boiler pressure were still more reduced, until it became less than the atmospheric pressure.

Multiplying (21) by $\frac{2\pi R^2 l n}{33000}$

$$IHP = \frac{\pi R^2 l}{33000} \left[-hn + \frac{(h+P_0)(h+P')n}{h+P_0+E(b+c)n} \right] \quad (22)$$

This equation corresponds to (10).

The condition of maximum IHP for constant P' is

$$\frac{(h+P_0+E)(h+P_0)(h+P')}{h} = \left[h+P_0+E+(b+c)n \right]^2 \quad (23)$$

This like (11) is the equation of a parabola. The value of n is

$$n = -\frac{h+P_0+E}{b+c} \pm \frac{1}{b+c} \sqrt{\frac{(h+P_0+E)(h+P_0)(h+P')}{h}} \quad (24)$$

The slope of this parabola is

$$\frac{dP'}{dn} = 2 \frac{h}{h+P_0} (b+c) + 2 \frac{h}{h+P_0} \frac{(b+c)^2}{h+P_0+E} n^2 \quad (25)$$

which when $n=0$ is

$$\left(\frac{dP'}{dn} \right)_{n=0} = 2(b+c) \frac{h}{h+P_0} \quad (26)$$

while the line of zero load has the equation

$$h+P' = \frac{h}{h+P_0} \left[h+P_0+E+(b+c)n \right] \quad (27)$$

as is readily determined from (22).

The writer has examined engines in which the friction pressure increases with the pressure of the supply steam at constant load. The value of P_0^* then becomes $P_0 + en$, and the surface of brake horse-power as a function of mean effective pressure is then represented by equations similar to that which in this paper

represent brake horse-power as a function of boiler pressure. The discussion then becomes more complex, although it can be made on the lines here laid down. It is better to avoid this discussion by refraining from building such engines.

The experience of the writer with condensing-engines has been very limited, but it would appear that the equations here given will apply also to them.

The four surfaces here discussed may all be constructed by means of threads to represent the two sets of rectilinear elements in each. These are constant speed, and constant load. Such models represent the working conditions of an engine in a most interesting way.

Nipher, Francis E.,

Report on Missouri Rainfall, with averages for ten years ending December, 1
887 On the output of the non-condensing steam engine as a function of
speed and pressure

[St. Louis, Mo.] [1889]

Phys.sp. 483 i,1/14#Beibd.13

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